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WEATHER CONTROLS OVER THE FIGHTING IN THE ITALIAN WAR ZONE

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SO obvious have been the weather controls over military operations in the present war, that even the layman has not failed to note the importance of this factor in the course of his reading of the war news in his daily paper. In every-day conversation mention has often been made of the rain and the mud in Flanders; of the heat and drought of Mesopotamia; of the snowstorms of the Trentino; of the hazy spells usually selected by the Germans for their air-raids on England. The subject is one which merits careful study. It has an interest as a matter of historical record. But it also has a very immediate and a very practical side. By means of daily weather forecasts, such as are now being made by the expert meteorologists on all the war fronts, the military commanders are often able to plan operations in such a way as to take advantage of weather conditions favorable to their purposes, and, at least to some extent, to guard against those conditions which are hostile. Again, a knowledge of the climate and weather of the different war zones, and the experience which the armies have already had with them, may be of immense benefit to us, now that American troops are already on the firing-line on the western front and may soon also be engaged on other fronts. For our military tactics; the clothing and equipment of our troops; the whole matter of our transport; the organization of our aviation service, all depend, far more directly than most people realize, upon the weather. With the matter of daily forecasts, the present paper is not concerned. What is here attempted is to bring together such meteorological facts and controls, from one of the most interesting of all the war zones, as may help in an understanding of the campaign in that area up to this time, and may, if American troops are sent there, be of practical service.

In the matter of meteorological interest, the most dramatic fighting thus far during the war has taken place in the mountains. In the earlier months of the war, the Russians against the Teutonic allies in the Carpathians; somewhat later, the Russians against the Turks in the Caucasus and on the highlands of Asia Minor; and, since the spring and summer of 1915, the Italians against the Austrians and now against the Germans, in the Alps, have had the hardest fighting against weather conditions. Because of the present interest in the Italian war situation, the present paper will deal with some of the larger and more striking weather controls in that particular area.

There are three subdivisions, climatic as well as topographic, of the Italian war zone: the Alps of the Trentino, the Carso plateau in the east, and the northern lowland. Of these, the Alpine section has been the scene of the longest fighting, and also presents the most striking meteorological controls. It is, therefore, here first considered. No other part of the Great War has been fought for so many months under equal conditions of hardship. Nowhere else has the struggle between man and man been accompanied by so continuous a struggle between man and nature.

The Alpine complex lies as a barrier between the climates of northern and western Europe, with their relatively mild winters, moderate summers, and rainfall fairly well distributed throughout the year, and the Mediterranean province on the south. The latter, because of its irregularity of outline, vertical as well as horizontal, has many varieties of climate, all relatively mild, except at higher elevations, and with winter rains over most of the area. Owing to the great diversity of Alpine topography, it is impossible to give any detailed description of the climates of the peaks, the slopes and the valleys. Moreover, sufficient meteorological records are lacking for such a presentation. In any such varied topography, temperature, humidity, cloudiness, rainfall, snowfall, winds, are so largely controlled by local conditions of altitude, of exposure, of the immediate surroundings, that every place has, in a sense, its own climate. The effect of altitude upon temperature is often offset by the control due to topography or to exposure. The severe winter cold of the deep valleys during clear, calm spells seems less unbearable than higher temperatures, accompanied by furious gales, on the mountain peaks and upper slopes. Thus, while a detailed description of climates is out of the question, it is also true that a generalized account must be very broad. This much may be said: High mountains mean cold and snow, even in summer. They mean more clouds and rain and thun-

derstorms than the lowlands have. They mean more wind; more violent storms; deeper snows; a harder struggle against the elements. Severe, indeed terribly severe, have been the meteorological handicaps in that mountainous country where fighting has been going on in the clouds, amidst ice, and deep snows, and avalanches.

The war in the Alpine sector began in the warmer months of 1915. Yet even in that milder and more peaceful season of the year, weather controls at once played their part. Late spring and mid-autumn are times of frequent and heavy rainfall in that region. Hence swollen rivers, flooded passes, deep mud, "bad weather," were to be expected and were experienced, even in summer. Over and over again, heavy rains and "fog" checked the fighting. These "fogs," often mentioned in the despatches, are doubtless in most cases not real fogs, which lie on the ground, but clouds, for much of the fighting has taken place at altitudes well within the cloud zone. Such "fogs" often interfered with artillery firing and with aeroplane observation, but were several times taken advantage of, by one side or the other, for making surprise attacks. Summer lightning played among the troops fighting on the rocky mountain-sides. Torrential downpours swept the passes and temporarily stopped engagements. Hail beat in the faces of the men as they charged up the steep slopes. In view of the well-recognized importance of snow in the later (autumn-winter, 1917) developments along this Alpine front, it is worth noting what the conditions were earlier in the campaign. June 21, 1915, a despatch from Brescia noted the occurrence of a heavy snowstorm on Monte Altissimo, with temperatures below zero (C.). The despatches of June 24 mentioned that there were more than 2 feet of snow on the lofty Stelvio pass, where spirited fighting was going on. On July 1, 1915, it was reported that "the mountaineers (Tyrol) do not remember a season when there has been so much snow on the heights on July 1. The mountain streams, which are usually dry at the end of June, are now deep and almost impassable. The Italian troops are encountering snowstorms and thick fogs, which have interfered with long-range firing." Snowfalls toward the end of September, 1915, checked the fighting.

The two winter campaigns (1915–16, 1916–17) in the Alps brought, as was to be expected, snows many feet deep; howling gales, avalanches, and bitter cold. Under such conditions large-scale operations were not possible. Many precautions had to be taken. Snowshoes and skis, extra-heavy clothing, blankets, fur chest protectors and sleeping-bags, and foot-warmers were

supplied. White coverings were worn for protection amidst the snows. To supply the troops with warm clothing, offices were opened in the Italian cities, where furs of all kinds were brought in to be made into winter garments. Provisions were assembled in specially-constructed weatherproof huts. The shelters for the men were fitted with stoves. The trenches were lined with straw and boards. Special arrangements were made for supplying hot rations to the troops. Galleries dug under the snow were several times used as a means of approaching the enemy's trenches. In spite of all precautions, hundreds of the troops were invalided home with hands and feet frost-bitten.

After the remarkable Teutonic offensive, in mid-autumn, 1917, which brought the Austro-German troops down on to the plains of northern Italy and for a time seriously threatened Venice, military operations were suddenly and most aggressively renewed in the Trentino sector, chiefly in the region of the Asiago plateau. The enemy made desperate attempts to capture the mountain positions and to penetrate on to the lowlands, in order to turn the Italian left flank and thus make the Piave line untenable before winter should make such a task impossible because of snow-blockades in the mountains. Once again the terrible winter weather of that rugged country played its part in the fighting. The Teutonic advance began "in driving snow, and cold, and pouring rain" (second week, November, 1917). The official and other despatches mention bitter cold (November 27, 14° F.); lack of shelter owing to the terrific artillery action and the constant shifting of positions; insufficient supplies of water; drifting (though light) snow; biting winds; the use of caves "from which hung huge icicles" for shelter. One account notes the fact that the Italians were often "compelled to remain motionless for a long time lest they should be discovered by the enemy against the whiteness of the snow."

That the coming on of winter at once, and in full vigor, with deep snows, and raging "blizzards," would have been the best possible ally to the Italians, was well recognized by all the military commanders. For in normal winter weather, the Teutonic lines of communication both by railroad and also by the narrow mountain roads, would be paralyzed, or at least badly blocked, and the transport of heavy artillery, of munitions and of supplies would become difficult or impossible. Each additional day that the Italians were able to delay the advance of the Austro-German armies brought winter's help one day nearer. Each day made the Teutonic offensive more difficult. It is,

therefore, easy to understand why the enemy's general staff was ready to make such continuous and desperate attempts to break through before the worst of the winter weather should come on. The fighting was against time. A winter campaign on the lowlands is far more practicable than in the mountains, owing to milder weather, and little snow. From numerous reports, coming from various sources, it is clear that the early part of the present winter (1917) was unusually favorable to the enemy. It was cold, but usually clear, and the heavy snowstorms characteristic of the late fall and early winter were entirely lacking. The snow, instead of being several (5–10) feet deep in the mountains, as it was a year ago in November and early December, was (up to mid-December) only a few inches deep in most places. A despatch of December 6 said that one deep snowfall "would be worth divisions to the Italians." Gen. Diaz said on December 9, "with normal winter conditions prevailing in the north, the enemy would now be in the grip of impassable snows." Small wonder is it that the Italians prayed for snow in the mountains; and for an end of what they termed "Austrian weather" which they felt had lasted from the first day of the retreat from the Isonzo front. Light snows fell from time to time, but the long-hoped-for deep snows did not come. It is always natural that man should overestimate, or underestimate, the extent of meteorological conditions which are helping or hindering him in warfare. Hence it is both interesting in the present survey, and as a matter of historical record, to give here an Associated Press despatch, dated Italian Army Headquarters in Northern Italy, December 25, which gives, on the authority of an Italian meteorological expert, the actual conditions as to the meteorological characteristics of the early winter of 1917.[1]

The entire mountain region, where heavy fighting has been going on in recent days, is having the unusual experience of a holiday season with green slopes and summits and little or no snow. One of the generals on the front said that every foot of snow was worth divisions in obstructing the enemy.

"This is one of the mildest winters we have ever had," said the major in charge of the weather branch of the high command, "and from a military standpoint the weather conditions are of the highest importance both for our troops and, particularly, in their effect on the enemy's transportation of supplies and troops."

Taking the report furnished by the high command to-day on the

[1] The special meteorological service organized in connection with the Italian military staff has already published several bulletins dealing with military meteorology. Among the subjects so far considered are the climates of the various districts within the war zone, also details regarding avalanches, with lists of places especially subject to them.

weather at all vital points, the major pointed out the extreme variation in the mountains, plains and valleys.

Here at headquarters the report showed two degrees above zero Centigrade (35.6° Fahrenheit) and no snow, while the same report showed —15° Centigrade (5° Fahrenheit), and seven feet of snow in the Ortler Alps.

Further east, in the Adamello Alps, which are the next highest to the Ortler, there are about three feet of snow as compared with nine feet last year.

Around Lake Garda the condition is much milder. Monte Pasubio, where the Austrians made their big drive last year, now has four feet of snow, as against twelve feet last winter. But all these snow-covered points are in the active military region for the present.

The entire area of the present fighting in the Brenta valley is free from snow and the weather is mild. This is the valley where the Austrian route brings supplies and troops from Trent and the Asiago and Brenta fronts. Between the Brenta and the Piave rivers, which is the principal region of the fighting, Monte Grappa, which usually has four to six feet of snow, now has only ten to twelve inches on the northern slopes and six inches on the southern slopes. The temperature is from —5° to —12° Centigrade (23° to 10.4° Fahrenheit).

Montes Asolone, Pertica and Bolarolo, where the heaviest fighting has occurred in the last few days, have only a few inches. It varies from three to five inches and seldom lasts, owing to the mildness. In the foothills there is no snow and the temperature is always above freezing.

The reports show similar mild conditions in the Carso and the Julian ranges to the east, through which the Austrians maintain their communications with the invaded regions of eastern Venetia. The mildness is so pronounced that the enemy is able to operate four distinct lines of communication leading to Gorizia, Udine and Venetia.

The unusual weather conditions are proving an important factor in the campaign, for while severe cold and heavy snows would hold the enemy in their grip, the present mild and almost snowless season permits operations to proceed.

Late in December (31st), the despatches noted the fact that enough snow had fallen to make transportation difficult.

One larger consequence of a slackening of operations in the Trentino sector may be mentioned. Heavy snows there would doubtless mean the transfer of large numbers of Austro-German troops to the western front, to the lowlands, or, in case of an Allied attack on Pola, to that section.

The other portions of the Italian war area, the plateaus (Carso, Bainsizza) in the northeast and the eastern portion of the northern Italian lowland, may, in conclusion, be considered together. For the general temperature conditions of the plateau, the records of three stations, grouped together, at an average elevation of 1,700 feet may be noted. These have a midwinter (January) mean of 30°; a midsummer (July) mean of 66.7°, and an annual mean of 48.4°. Their *average* lowest temperatures in winter are 5.4°; their *average* highest tempera-

tures in summer are 84.4°, although in any single year the minima and maxima are likely to vary several degrees lower or higher. For purposes of comparison, Laibach and Trieste may be added.[2]

In winter, the plateau is noticeably colder than the immediate coast, and cold northerly winds are very apt to blow from the interior down to the northern shores of the Adriatic.

Trieste has a mean annual rainfall of 42.83 inches, with an average of 109 rainy days, the rainiest months being June and October; and the driest, December to April and July–August. Göritz has a mean annual rainfall of 63.50 inches; 139 rainy days; maxima in June and October, and minimum in January and February.

More or less fighting has been in progress on the Carso plateau since Italy entered the war. Here, in the late summer and autumn of 1915, the men suffered from the heat, even in their light gray cotton uniforms, and later the general cold-season storms of that region, and the fogs, often interfered with military operations. The time for the great main Italian offensive, about the middle of May, 1917, seems to have been chosen between floods on the Isonzo River. The troops were able to cross on pontoons. Usually at this season the river is practically impassable except on fixed bridges, for this is the time when the spring rains and melting snows in the Carnic Alps cause the rivers to flood. The passage of the Isonzo was forced in a heavy fog. Italy's strong offensive on the Carso plateau could not be begun any earlier on account of "terrible atmospheric conditions." Great difficulty was experienced because of lack of water on this dry plateau. Each day, according to one despatch, 450,000 quarts of drinking water were carried up to the thirsty men. Temporary relief, both in supplying water and in limiting military operations, resulted from thunderstorms and occasional general rains. Early in July (10th) the Austrians began a night attack, on the Vodice, in a violent thunderstorm. In the darkness the enemy had almost reached the Italian positions when a sudden flash of lightning revealed the attacking party, which was completely repulsed. Stifling heat was reported late in August. It is worthy of note that the southern soldiers of Gen. Cadorna's army were espe-

	Laibach	Trieste
[2] January	27.5°	37.8°
July	67.3°	73.6°
Year	48.2°	55.2°
Mean min.	—0.4°	19.6°
Mean max.	88.7°	93.9°

The warmer winters of the coast are clearly indicated.

cially mentioned for their valor and fighting abilities during the conquest of Monte Santo. Gen Cadorna evidently pushed his troops to the utmost in order to smash the Austrian armies and to gain as much territory as possible before winter should make large-scale operations impossible. There were signs, also, that Italy was preparing for a winter campaign against Trieste when operations could no longer be continued farther north. There were two classes of difficulties, both directly or indirectly climatic, which added greatly to the already seemingly impossible task of the Italian armies. One of these was the problem of supplying water to the men who were fighting on the dry plateaus and on the mountain slopes far above the rivers. Until pipe-lines could be laid, water was carried up, in small quantities, on the backs of men, to the thirsty soldiers who could often look down, thousands of feet, on to the rivers running in flood far below them. The other difficulty was the stormy autumn weather. Heavy rains changed peaceful streams into raging torrents. Fogs and mists interfered with visibility. Increasing cold added to the discomfort and suffering.

The great Austro-German offensive began in the last week of October. The Italian front lines were broken through (October 24) "in a drenching rain and mist, under the most depressing conditions," which rendered the Italian barrage ineffective in opposing the onslaught. As one correspondent put it, "Austria is hiding behind the skirts of autumn." The Italian mountain positions "were surrounded and made untenable before the fog lifted." The use of deadly gases was favored by a light wind and the damp air. Several days of stormy weather were followed by a fine spell, which favored a rapid advance on the part of the Teutonic troops, across the mountains and through the valleys. During the earlier stages of their retreat, the Italians suffered greatly from cold torrential rains. Much interest centered in the stages of the Italian rivers. It appears that, while the heavy rains added to the difficulties of the hurried Italian retreat, they also delayed the enemy's advance, by swelling the rivers, softening the ground, and preventing effective reconnaissance and bombing on the part of the enemy aviators. The reports regarding the condition of the Tagliamento, the Livenza and the Piave rivers were very contradictory. These are not broad, deep and swiftly-flowing streams, always difficult to cross, but vary greatly according to the rains, becoming shallow during fine spells. Apparently at times the invaders were favored, and at other times the defenders. On the whole, the balance seems to have been in favor of the Teutonic troops. The Piave was reported as

flowing with a full head of water in mid-November, owing to recent heavy rains. These same rains helped to flood the lowlands. The sector of the lower Piave was further rendered difficult to cross by the release of the flood-waters through the opening, by Italian engineers, of the dikes, so that a considerable area to the north of Venice was several feet under water. On December 13 a report noted the occurrence of "downpours" during two days, filling the Piave which had nearly "run dry," and effectively flooding the inundated section over which the waters had fallen from 5 ft. to 1 ft. Taking advantage of this low water, the Austrians had made an advance. The high and low stages of these rivers have been a constantly fluctuating factor in military operations on their banks.

The larger climatic characteristics of the Italian lowland, across which the battle-front now stretches, are well shown in the excellent meteorological records which have for years been kept at several of the larger cities. Thus, Venice, Vicenza and Padua have midwinter (January) mean temperatures of about 35°, midsummer (July) means of about 75°, and mean annual temperatures of about 55°. Venice has the highest values (1.5° to 2° F.) in each case. The absolute minima have been between 7° and 15°; the absolute maxima, between 95° and 100°. Belluno, at about 1,300 ft., has slightly colder winters (30.2°), somewhat cooler summers (69.3°), and a lower mean annual, 50.9°. Its lowest reading is 4° (3.9°) and its highest nearly 100° (99.7°). "Mediterranean" climates are as a whole distinguished by comparatively moderate rainfalls, and by dry summers. These stations on the northern Italian lowland, however, have a somewhat different rainfall distribution. They are alike in having a minimum in the winter, and maxima in spring (May) and autumn (October). The amounts vary as follows: Belluno, 50.67 inches; Vicenza, 47.56 inches; Padua, 33.70 inches; Venice, 29.53 inches. In addition, Udine has a mean annual of 60.94 inches; 145 rainy days; maxima in June and October, and minimum in January–March. In the Venetian Alps the rainfall is much heavier. The number of rainy days is between 100 and 125; the probability of rain usually being greatest in May and October, and least in August.

Northern Italy is on the track followed by storms coming, in winter, from the Gulf of Genoa or from the western and southern Mediterranean, and moving in an easterly or northeasterly direction. These storms bring general rains, and occasionally snow. Snow is, however, infrequent, as is seen by the record of an average of days with snow, as follows: Venice, 2.0; Vicenza, 3.9; Udine, 4.3; Padua, 4.7; Trieste, 6.5.

PARASITES IN WAR TIME

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PARASITES, always of major importance in tropical countries and of considerable importance in the temperate zones, take on increased importance with the onset of war. In a general way this is due to two factors. In the field of human medicine it is due to the fact that the sanitary and hygienic provisions of armies in the field can not maintain the high level attained in peace times among civilian and soldier elements of the population, while the throwing together of persons of the most diverse habits of cleanliness and regard for personal condition, under such unfavorable circumstances, affords a chance for the spread of such parasitic pests as would under ordinary conditions be confined to those who were habitually careless or unmindful of these pests, or who were exposed to them by virtue of geographical or environmental conditions. In the field of veterinary medicine, the increased importance of parasites is due, not only to the spread of parasitic diseases among horses purchased all over the country and brought together on the picket line, but also to the fact that present-day war conditions call for the conservation of all resources, especially food and factors in food production, and for the elimination of losses from parasites which in peace times may be ignored as matters concerning only the individual who sustains the loss, but which in war times must be regarded as subtractions from a relatively limited and highly necessary sum total of the common possessions of the nation, the loss of which ranks with losses in battle as factors in defeating our armies and the ends for which they fight.

In the field of human medicine, there are two problems: The immediate problem is the control of parasitic diseases and the diseases, bacterial or otherwise, associated with the parasites; the remote problem will concern itself with preventing the importation into this or other countries heretofore free from them, of the various exotic diseases with which soldiers may be brought in contact by association with troops brought from tropical and semi-tropical regions where these diseases are prevalent.

Among the parasites of man that deserve mention, lice should be regarded as of first importance. Wherever men are thrown in close physical contact in the trenches and dug-outs and in crowded billets in the wrecked structures still standing in the vicinity of the contested areas in France, there is ample opportunity for the spread and multiplication of these annoying and dangerous parasites. Leiper has referred to these pests as the "minor horrors of war," and they are not peculiar to present-day trench warfare. The world's wars have regularly been fought by lice-infested soldiers. In our Civil War lice were familiarly known among the soldiers as "graybacks" and anecdotes of that conflict commonly deal with these ubiquitous insects. It is said that General Mott once stopped in a walk through a camp to observe with interest the close investigations that Private Lindaberry was conducting along the seams of his shirt. "Are you picking them out?" he asked. "No, sir," was the reply, "I'm taking them as they come." It might be noted in passing that this method of hand-picking, elsewhere applied to the eradication of the cattle-tick and the boll-weevil, is still used as a practical means of control for lice in the present war—a palliative, if not entirely remedial, measure. As an illustration of the utility of applied entomology in this connection may be noted the practise of placing lousy garments on ant hills, which is said to result in the careful removal of the lice by the ants. This is not a particularly valuable or widely applicable method, of course, but the purely entomological aspects of louse control are so important that Vaughan has recommended that entomologists versed in medical entomology be attached to our army units.

Louse control, however, calls for a knowledge of more than entomology. It presents large problems in therapeutics, the therapeutic agents employed being primarily insecticides within the field of medical rather than entomological science. Over two hundred insecticides (and substances suspected, often on very little evidence, of being insecticides) have been tested since the outbreak of war, and the large literature dealing with this topic which has appeared since 1914 is still in poorly digested condition, with varying and often conflicting claims for the same insecticides. However, experience has established beyond question the value of kerosene and gasoline in controling lice, as these substances kill both the lice and the eggs, or "nits," very quickly. In some instances, companies of men have been stripped and thoroughly sprayed with these substances, with excellent results in controlling the trouble and

with but little personal discomfort on the part of the men. As regards ointments for individual use, ordinary petrolatum (vaseline, cosmoline, etc.) has been found quite effective and is rated by Castellani with kerosene or gasoline as among the most effective insecticides. For the most part, however, the clothes louse, or body louse, the most important of the lice attacking man, lives in the clothing, especially in the seams, and must be killed here. For this purpose dry heat affords a very satisfactory control measure, an adequate heat resulting in the coagulation and desiccation of the protoplasm of the louse and its egg. In addition to sprays, applications and heat, there is quite a range of supposedly valuable remedial and preventive measures, including sachets of various designs and contents, muslin underwear impregnated with sulphur and naphthaline, body cords smeared with mercurial ointment and worn about the waist, ordinary soap-and-water cleanliness—and even chiropractic measures have been advocated. It appears that the correct chiropractic procedure, according to the publication cited, involves an adjustment of the first lumbar vertebra, but offhand it would appear better to confine manual manipulation to hand-picking or else apply the pressure to the lumbar region of the louse rather than to that of the patient.

The importance of lice is due less to their own irritating activities as blood-suckers than to the fact that they carry the dreaded typhus fever germs; the prevention of typhus is lice control. This is a menace to which our army is now and will be exposed. It is impossible to raise large armies without including louse-infested individuals, and Vaughan notes that we had such individuals in our army on the Texas border, though there was no exposure to typhus. But since lice are a menace and freedom from lice a defense in the presence of typhus, our medical corps will need to devote considerable attention to delousing measures for the protection of our troops.

Another parasite which attacks from the outside is the itch mite, the cause of itch, or scabies. This little relative of the spiders burrows in the skin, causing an itching sensation, and the fingers of the victim, in an effort to relieve the itching, complete the job of producing sores and scabs. An interesting bit of news from the front in this connection is to the effect that soldiers suffering from this distressing complaint have been cured by exposure to chlorine gas during gas attacks by the Germans. Subsequently the proposal has been made to clear out certain insect pests in valley lands by the use of heavy poison gases as an agricultural measure.

The numerous biting flies and mosquitoes frequently find exceptionally favorable opportunities for breeding in war areas where remedial measures, such as oiling bodies of water or draining them to prevent mosquito breeding, can not be applied to the contested No-Man's Land. Trench-helmets are no protection from these flying projectiles, though a gas-mask might be! Perhaps even more favorable are the opportunities for the breeding of the numerous non-biting flies which live as maggots in dead bodies of horses, other stock and of men. Many of these maggots readily adapt themselves to life in wounds and in the summer or in the more tropical war zones, infestation of wounded and sick men with these maggots becomes a rather common and often serious complication. It is rather surprising to find, however, a statement from a medical officer in the war zone to the effect that gas gangrene, one of the most serious conditions encountered in this war, rarely appears in wounds infested with maggots.

Among the worm parasites, hookworms deserve especial consideration in this country, since a large part of our army comes from the hookworm-infested sections of the South. Stiles has already called attention to the occurrence of hookworm disease found among our soldiers from the South and urged the desirability of detecting such cases and using the appropriate anthelmintic treatment to rid these men of their parasites. The importance of this action is fairly evident. Hookworm disease results in anemia, lassitude and inertia, and the task of overthrowing Prussian militarism and the armed application of Pan-Germanic philosophy can not properly be regarded as a task for anemic and inert troops. The examination of soldiers for hookworm disease would incidentally disclose other parasitic infestations. Hookworm disease is contracted commonly by the invasion of the skin by the larvæ, which develop from hookworm eggs in the excreta of hookworm subjects, and trench conditions afford uncommonly favorable conditions for the spread of this disease. It is true that adequate measures are taken for the disposal of excreta under most of the working conditions of the present war, but there are many extraordinary conditions under which these measures can not be taken, and in spite of the care and authority of medical officers there are always men who neglect or ignore the provisions made for the common safety and welfare. And it is precisely the men accustomed to the lack of sanitary provisions in infected rural communities who might most easily fail to appreciate the value of these provisions under the stress of war conditions. An-

other aspect of the matter is this: This continent is practically free from the Old World hookworm, *Ancylostoma*, but so is Europe practically free from our Afro-American hookworm, *Necator;* while we would not be grateful for an importation of *Ancylostoma* in returning troops, neither would our allies approve a dissemination of *Necator* by our soldiers abroad.

Among the worm parasites, *Strongyloides*, a worm associated with a diarrhea, has a peculiar interest. This parasite also occurs in this country and Stiles has recently recommended that soldiers so infested be discharged, for the reason that no satisfactory treatment for this condition is known. In view of the lack of a known dependable treatment and the disability due to the disease, this is good advice—but may we now expect our slackers to seek an infestation with *Strongyloides* to escape army service?

The same difficulties in sanitation that make the acquirement of hookworm infestation easy make it easy to acquire *Strongyloides* or the other common intestinal parasites, such as ascarids, whipworms and pinworms. It may also be found that infestation with the dwarf tapeworm, *Hymenolepis nana*, the commonest tapeworm parasite of man in this country, will spread in the war zone. Reports state that the trenches swarm with rats, and as this tapeworm appears to be normally a parasite of rats, occurring in man as a result of the contamination of food-stuffs by these enemies of mankind, it is conceivable that this worm will need attention.

Rats, however, have an importance in connection with disease which exceeds their importance as carriers of the dwarf tapeworm. They are the reservoirs of the dreaded bubonic plague and the rat fleas commonly present on them are the habitual transmitters of the disease from rat to rat and from rat to man. Should plague-infested rats appear among those in the trenches, practically any measures for combating the rats would be justified and the campaign against the Central Powers would have to be subordinated to a rat-killing campaign in which the use of poison gases would probably be a weapon of major importance in destroying rats and fleas alike.

The conditions of present-day warfare also afford opportunity for the spread of disease, characterized in part by diarrhea, due to amebic and flagellate protozoa. These minute organisms may be spread rather directly from the excreta or carried from the excreta by flies. These diseases are already present on some fronts and are receiving a considerable amount of investigation along the lines of preventive measures and treatment.

The more remote activities of our medical corps in preventing the importation of exotic diseases of a parasitic nature may only receive brief mention here. Such diseases as coccidiosis, a protozoan disease, occurring in the Balkans and elsewhere, are not known to occur in man on this continent, nor is bilharziasis, a disease occurring, among other places, in Egypt. In the latter disease, worms may occur in the blood vessels of the lower bowel or of the urinary bladder, causing an inflammation and hemorrhage of these organs as a result of the passage of their eggs through the tissues. The list of parasites of man not known to occur in this country and known to occur in some of the widely distributed war areas is a long one, but it is unnecessary to enumerate. Our medical corps can be depended on to take the necessary measures to prevent our troops from becoming infested and to provide proper treatment or adequate quarantine for those who by carelessness or inadvertence become infected.

In this connection it might be noted that war conditions call for new investigations in the field of anthelmintic treatments for worms. Along with the cessation of importation of other drugs due to the war, the supply of thymol, the drug commonly in use in this country before this war for the treatment of hookworm disease, was shut off, with the result that a superior remedy, of American origin, oil of chenopodium, has come into general use. The plant from which this remedy is obtained is one that was used by the Indians before Columbus discovered America and has been used as a home remedy and by the Southern "mammies" for many years, but it required a war, with its stoppage of commerce, to bring about a high degree of interest in this American product.

In the field of veterinary medicine, as has been noted, there is ample opportunity for work in controlling parasitic diseases among horses in the army and in preventing enormous losses to our live-stock industry by eradicating parasites. Of major importance are such diseases as Texas fever of Southern cattle, a disease caused by a protozoan parasite in the blood and carried by an external parasite, the cattle tick; scabies in cattle, sheep and horses, due to mites closely related to those causing itch or scabies in man; stomach-worm disease of sheep, due to a blood-sucking worm; and "worms" in pigs. Other parasites which do much to swell the grand total of losses are the various lice, true ticks and so-called ticks, and other biters and blood-suckers which live on our stock, and the lungworms, hookworms, palisade worms, tapeworms and flukes which live in them.

The increasingly successful campaign against the cattle tick which carries Texas fever is an epic in the warfare of veterinary medicine against disease. It is a warfare in which the names of great leaders, executives and laboratory men stand out conspicuously, men from the U. S. Bureau of Animal Industry and from the experiment stations of the Southern states. In a warfare as real and as systematic as the conflict of militarism and democracy, the tick has been attacked from a quarantine line that once extended rather directly across the United States from Virginia to California and from this far-flung battle-line the tick has been driven toward the Gulf of Mexico from county to county and state to state. Wedges have been driven into the line and the tick forces have been split by drives down the Mississippi River states. Recently, December 1st, the entire state of Mississippi was released from quarantine and the governor designated the day of release as a day of rejoicing to celebrate the event. In the general order releasing this state a total of over 65,000 square miles was released. At first the campaign against the tick was a scientific problem, the study of the foe's weaknesses, habits and life history and the development of offensive and defensive weapons. This problem was presently solved; suitable dips to be readily applied by swimming the cattle through a dipping vat furnished the weapons with which to begin an offensive. The quarantine line blockaded the enemy and kept the tick from fresh supplies of food among the Northern cattle. The problem then became one in diplomacy. At favorable points the tick was able to make a stand with the aid of strong allies, uninformed, misinformed or hostile individual stockmen who objected to dipping, who met the inspectors with a club or a shotgun. It is a striking feature of this phase of the tick-eradication campaign that men trained only as veterinarians should have acquitted themselves so admirably in such delicate and dangerous situations. With a minimum amount of actual clash and combat, this opposition was overcome by argument, persuasion and friendly discussion. There is little of this opposition remaining, the task is more than half completed, and the work yet undone is hastening to a conclusion. The time is fast approaching when through the cooperation of the federal and state authorities the last tick will be dipped or collected as a museum specimen, or whatever is appropriate for a last tick, and the tick and Texas fever will become extinct in this country. Already the slogan is "A tick-free South in 1921." When that time comes, the South, with its abundance of feed, rich soil,

abundant rainfall and long-growing periods for crops, will take over a large part of the live-stock industry of this country. Were the tick eradicated right now, in this fourth year of the great war, it would immensely strengthen the hands of this country in coping with the problem of meat supply during that war. The annual losses attributed to the presence of the tick are estimated at $50,000,000, a loss of meat and leather that is especially hard to contemplate at this time. The cattle tick is a very real enemy that deserves to rank in destructiveness, if not in wilful *Schrecklichkeit*, with the invaders of Belgium and the destroyers of the *Lusitania*.

While the campaign against the cattle tick has been pressed in the South, the drive against sheep and cattle scabies in the West has pushed on until the objectives have been almost attained. These diseases have cost this country dearly, and at one time sheep scab was the terror of the Western sheepman. At the present time the only terrain still held by the enemy is in California and Texas, where there is still some sheep scab. Cattle scabies has been practically exterminated over the one and a quarter million square miles first quarantined. The saving in wool, leather, mutton and beef, all unusually valuable in these days of war, constitutes an indemnity that repays us many times for the outlay which it has cost to prosecute this campaign.

Unfortunately, the report with regard to another enemy of our live-stock, the stomach worm of sheep, is not so cheerful. Sheep suffer little from bacterial diseases and are immune to tuberculosis, but they are attacked by numerous animal parasites and by an ally of the parasites, the sheep-killing dog. The ownerless cur and the uncontrolled sheep-killer stand with the stomach worm in opposition to the sheep and mankind and are at this time nullifying much of our efforts at conservation by their attacks upon the mutton and wool supply of this nation. There are medicinal treatments and preventive measures of great value in controlling stomach-worm disease, but these measures are not generally known and used to anything like the extent they should be. It would perhaps be well for the federal and state agricultural authorities to send well-informed men into communities where sheep were kept, to explain and demonstrate these methods. As for the sheep-killing dogs, they should be placed by law beyond protection and made the legitimate prey of any one who can find the time to shoot them or otherwise remove these parasites of the sheep industry.

The big ascarid worms of pigs are another constant source

of loss to our live-stock industry, and are especially severe in their effects on young animals, a general truth in regard to parasites. The U. S. Department of Agriculture has on a number of occasions urged the use of oil of chenopodium against these worms, and it is to be hoped that adequate measures of treatment will be used during the coming year, to aid in conserving our swine industry with its fat supply, which Germany found so suddenly and extremely valuable after her ill-advised slaughter of a large part of her swine to conserve food they might eat. There is at present a desire to control worm infestation in swine by the use of such procedures as feeding mineral mixtures of various sorts and various stock feeds. Such preparations may have value in furnishing mineral constituents to swine or in improving their appetites, but if they have anthelmintic value the writer is unaware of it and has not found it experimentally. Such preparations, if aimed at parasites, are ammunition wasted.

The numerous external parasites of stock can be, and decidedly should be, controlled by dipping, and there is no lack of suitable dips. Some of the internal parasites can be controlled by appropriate medication, whereas others need much more study, never more necessary than now.

Our newly reorganized Army Veterinary Corps will find ample occasion to recognize the importance of parasites in war times when they are compelled to cope with mange in cavalry, artillery and transport horses. At times certain stations in the French army have had as high as 60 per cent. of their horses disabled with this disease, and its control is not a simple matter. The presence of large numbers of lice on these horses will demand attention. Worm infestations in horses often occasion damage of a serious character, with the complication that these infestations are not readily recognized. That our veterinary corps will prove capable of coping with these conditions can not be doubted. The veterinary corps of the armies of the Allies and of the Central Powers have met the problems of modern warfare with the ready development of practical field measures, supplemented by research where necessary, and in the doing of this have been the recipients of numerous citations and decorations for conspicuous bravery under fire. The veterinary corps of the United States Army is calling into the service numerous veterinarians from private life to assist the small corps of veterinarians heretofore attached to our correspondingly small regular army, and in the development of practical and ingenious measures for meeting emergencies the American veterinarian will show himself second to none.

In attacking the problems of parasite control in war times, this country is fortunate in commanding the services of many able helminthologists, protozoologists and entomologists. There already are in the government service a number of these men, among whom might be mentioned Ashford and Craig in the army, Stitt in the navy, Stiles in the Public Health Service, Ransom in the Bureau of Animal Industry, Cobb in the Bureau of Plant Industry, and Howard, Hunter, Knab and Bishopp in the Bureau of Entomology and the Division of Insects of the U. S. National Museum. In addition there are many able and well-known men associated with these. Other men who may be drawn on are associated with such institutions as the Harvard School of Tropical Medicine, the Tulane School of Tropical Medicine, and the Rockefeller Foundation, while numerous other workers in these lines are scattered throughout the country. And we can count upon the assistance and cooperation of the numerous and able parasitologists of France and England in dealing with war-zone problems in parasitology.

No discussion of war-time parasites would be complete without mention of the profiteer that fattens on the body politic, the alien enemy that invades our institutions and destroys our substance, the slacker who, like the hookworm, is nourished by our organism but fails to function in its defense and support, but the treatment, remedial or surgical, for these parasites is not in the hands of our physicians and veterinarians; under the leadership of our able President, that affair is the affair of every loyal American.

THE CHEAPEST SOURCE OF INCREASED FOOD SUPPLIES

By Professor E. G. NOURSE

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AMERICA to-day is seeking every means by which she may increase her agricultural output, and particularly is she concerned in finding those means of increase which will impose the lightest burden upon her supply of labor and of capital. This is the moment's phase of a problem which had begun to vex us seriously in recent years, but which is bound to become vastly more difficult in the future—a condition toward which the present war is a distinctly aggravating force. One solution of the problem is to be found through a choice of crops such that each portion of our land area shall be utilized for the growing of those products for which it is naturally best suited.

We are talking much about thrift now-a-days. Surely no part of the thrift campaign can be more fundamental to our welfare than this which concerns itself with the thrifty or economically effective administration of those natural resources upon which we must depend for the production of the foods, textiles, and other material means of human well-being.

The European colonists who settled our eastern seaboard faced precisely the sort of problem which we are here discussing, viz., the selection for tillage of those crops to which the soil and climate of the new land were best adapted. Naturally the force of inertia was all in the direction of holding them to the cultivation in America of the slender list of staples which made up the bulk of the output of western Europe at the time. But in terms of soil and climate America was a far jump from the mother lands and, after a few early disasters, considerable changes were effected in the old farm practise. Taking counsel from the Indian, the settlers adopted maize and found in it a much more powerful ally in conquering the new lands than they had possessed in any of their accustomed cereals. In potatoes, both the sweet and the miscalled "Irish" varieties, they found a cheaper source of starchy food than from any product of their previous acquaintance. Of non-food articles, tobacco and cotton early established themselves in high esteem.

When the great army of American pioneer farmers poured

across the mountains to take up our agricultural domain they undertook to raise only the proved staples of their colonial predecessors and to do it by a simple system of extensive field culture. This was inevitable in view of the fact that they were pioneers going out to prove up on the land, not settled husbandmen expecting to bring it to its final condition of utilization. They dropped silk and linen from their wearing apparel and most of the delicacies from their diet. Little even of pleasing variety was left. But in the half dozen staple products they had what might be called the primary colors both of a diet and of a farm system. They had fat, starch and protein, and they had a few well-chosen crops with which to subdue virgin lands and lay the solid foundation of an enduring agriculture. But in neither case did they have the full spectrum. Their products were not capable of supplying the normal human desire for varied food or textiles, nor of catching or utilizing the varied productive power of different soils and climates. It is left to the modern day to produce the full rainbow of that achievement. And that is the point which I am driving at.

Possibly it can best be illustrated by giving something of a chronological account of the development of our resources as it has actually taken place. Whether we look north or south, east or west, we see very clearly that the process has been one of carving out the great chunks of territory suitable for certain staple products—the cotton belt, the corn belt, the wheat region. If you follow the main track of the pioneers you will walk over smooth prairies and fertile plains. While some hard labor was spent upon improving the hillsides of the northern colonies in early times it was south along the broader coastal plain that agriculture flourished and cotton plantations and tobacco fields expanded. And when the land chosen for this particular sort of crops was full, resort was not taken to land of other character by using it for other products. No, the tobacco fields of Virginia were repeated in the limestone soil of Kentucky and the cotton fields of the Carolinas and Georgia were followed by cotton fields of a like character culled out from among the varied resources of Alabama, Mississippi, Louisiana, Arkansas, and finally the black prairies of Texas.

Not less did northern agriculture push westward with its slender range of crops and its fastidious selection of lands naturally suited to their growth. The Genesee Valley of western New York, then Ohio, the greaat Northwest Territory, the Missouri Valley, and the Red River Valley of the North were stages in the journey. The march of corn was stopped at a dry frontier on the west and a frost line at the north, but wheat found

new provinces to conquer in the San Joaquin, the Inland Empire of Washington, Montana, and the Canadian Northwest. In general, the pioneer sidestepped the wet lands, the dry lands, and the rough lands. To him they were poor lands, even worthless lands. He had no need to be thrifty about land, for there was always plenty of it—in fact, too much.

But now the point of view has changed. We are close upon the limit of our resources and asking where we shall find more land with which to supply our ever-growing needs. And the answer is, by finding out what productive qualities exist in the acres which have been discarded in this early reconnaissance development of our country and, by suitable means, drawing out the full measure of this productive power. In not a few instances it appears likely that the stone rejected of the builders may become the head of the corner.

With the reclamation of her arid and swamp lands America has of late years become much concerned. Such endeavors, however, should consist not alone of dams and ditches and dredging operations. Sometimes in lieu of such works and sometimes supplementing them should go a wise choice of drought-resistant or of water-tolerant crops. The pioneer with his moist-land crops and his moist-land methods was baffled when he reached the subhumid zone in his westward advance. After one disastrous attempt he admitted defeat and withdrew, leaving the land beyond the 100th meridian as waste land and his primitive sod house as the monument of his ill judgment. But the "dry-farmer" has refused to let all those fertile acres go untouched when markets offer a good price for grain and fodder and meat. Hence he has reformed his tillage methods so as to conserve all the moisture possible. But furthermore he has chosen a different set of plants to help him, turning from the hard drinkers to a group of more abstemious habits, able to do their bit on 15, 20, or perhaps 25 inches of rainfall instead of 30, 35, or even 40. He has turned to durum wheat and milo maize, kafir corn, kaoliang, and the whole group of non-saccharine sorghums. And he has found in alfalfa perhaps the best of all the dry-land crops, not so much because it *wants* only little moisture but because of the fact that it *can do* with relatively little and will work for all it gets. Given much water, it will yield heavily and often, but, planted where rainfall is scarce, it will delve deep to bring up all there is in a 15-foot layer of the soil and thus yield one or at most two cuttings on the subhumid land.

Much work has been done in recent years, as we have begun to see the value of these lands, so good in all but one particular,

to find the crop by which at least a portion of their potential productivity might be realized. Scientific explorers of the Department of Agriculture since 1898 have searched far and wide to find whatever kind of plant life had been evolved by nature or developed by man to fit such conditions elsewhere as we face in America. Professor Hansen went back to the motherland of alfalfa in Turkestan to find in the driest habitat the most drought-resistant strain of the plant. We have gone to Arabia for the date palm, to Africa for kafir, Manchuria for kaoliang, but have not forgotten that for sheer "bone-dryness" our own cacti beat them all.

If we turn now to the question of wet lands it is evident, if one reads the history of the pioneers, that a very large part of our country was in its native state too wet for the plants with which the European settler was familiar. There are perhaps two reasons why this problem may strike one less forcibly than that of the arid lands. First, because the wet areas were, in general, smaller scattered patches, nothing so spectacular as our "Great American Desert" and also because a readier means of reclamation was at hand in even crude methods of drainage. But from the slough-holes of the glaciated North to the alluvial river bottoms of the South there are probably 80,000,000 acres of land—an area three times the size of Great Britain and Ireland—now useless because too wet. Most of this can be made productive only by the installation of drainage works, but it should be remembered that even so a wise selection of crops is necessary if the drained land is to be successfully utilized. For drainage removes the surplus water; it does not prevent flooding, and many soils, even when drained, are still of such a character as to be suitable only for special crops—rice, celery, cranberries, onions; not for the old stand-bys, corn, oats, wheat, hay and cotton.

Kalamazoo celery, Wisconsin cranberries, the onions from Iowa muck lands—not to mention peppermint and spearmint—are, I suppose, fairly familiar, but doubtless many people are not yet aware that within the last few years the South has begun to turn some of her over-moist lands to the raising of certain species of aroid—a subtropical root crop which thrives in wet environments. Most important is the dasheen, first cousin to the "elephant-ear" of your parks, its leaves a salad plant, its stems a vegetable surpassing asparagus, its tuberous roots a good substitute for potatoes and claimed to make a flour better than wheat. Not mine to boast of the dasheen, but it does appear to hold out much hope for profitable utilization of lands

in the Southeast with 50 to 70 inches of rainfall. It is now grown and milled commercially and in increasing amount.

One of the neatest illustrations of learning how to play one's hand in a wet country so that the surplus moisture takes the odd trick instead of losing the whole game was recently furnished by a small community in central Arkansas. These farmers had been following the conventional type of agriculture of the region —cotton and corn. But nearly every spring the River Petit Jean covered the fields with back water for a short time. So, while the soil of this section was good and the climate all that could be desired for most of the season, yet returns were poor because of a short period of submergence early in the growing season. Neither young cotton nor corn can bear to have their feet wet.

Levees are expensive and not altogether trustworthy; so two young men who owned a farm thought they would try to use the river instead of fighting it. They decided to ally themselves with a crop that could stand flooding, in fact that required it—rice. To this use their "buckshot" soil was quite as well adapted as for cotton and corn, and the river offers a cheap and abundant source of water supply for the later portions of the growing season. This shrewd choice of a crop has brought instant attainment of the potential productiveness of a section which would otherwise have remained a precarious venture in crop-making or have required the expenditure of much time and money before it would have been rendered suitable for corn and cotton. At the same time society would have been losing a valuable resource, for the lands which, by reason of soil, topography, climate and water-supply, are capable of producing rice are relatively rare, whereas corn and cotton thrive over very wide areas.

It would be wearisome to attempt to go into all the many kinds of agricultural unfitness which may be overcome by the judicious choice and adaptation of farming enterprises. The West has great stretches of lands which are alkaline—an infirmity which is frequently aggravated by the introduction of irrigation, but which may be combated by the use of alkali-resistant crops. In this group the sugar-beet has proved itself one of the best, though cotton bids fair to prove a worthy rival in the warmer portions of the alkali zone. Barley is probably the most successful representative of the small grains, and there is a fairly good list of forage plants, which—praise Allah!—includes a number of the legumes. For extreme conditions we have the ubiquitous cactus, now happily de-spined, and perhaps ultimately the Australian salt-bush.

Likewise the problem of sandy land has baffled many a cultivator accustomed to the technique of loam and clay. Even in the time when the colonists were belaboring the barren hillsides of New England they were not enough humbled to try the sandy barrens of New Jersey. But the modern truck and fruit grower is not too proud to fight for even such unpromising resources. The light soil is easily worked and, for such products as are made up mainly of water and a little sugar, is tolerably productive. Not only in New Jersey, but in practically every state in the South, fortunes are being drawn from such lands through the medium of berries, melons, peaches and numerous varieties of fancy vegetables.

But of all the agricultural Cinderellas, none presents more engaging possibilities than those offered by the hill lands. Probably we have not yet come as close to a sensible mode of using such resources as in the case of most other types of land. Certainly it would seem that it was in this field that the most egregious blunders have been made in the past, for flat-land agriculture *can* be carried on to the hills and persisted in (to the harm of the land and the impoverishment of the worker), whereas Nature more sternly turns men back from land too wet or too dry. We know that the hills of New England were pressed into flat-land uses by reason of certain peculiar circumstances and with most melancholy results. And in every other hill section—Appalachian, Ozark, or wherever—we find either that the early settler turned his back upon the hills or else essayed to raise his valley crops instead of devising a hill technique really suited to the circumstances. Hence the backward and unprosperous hill folk.

Allow me to illustrate this point from a situation with which I am somewhat familiar, the Ozark hills of northwest Arkansas. The first rush of land exploitation flowed to the north and south of this region. Grain farming took up the region to the north; the cotton planters, as has already been mentioned, swept through as far as Texas on the south, cutting out the most suitable cotton lands and spreading up the valley of the Mississippi, the Arkansas, the Red River, and the White. When Oklahoma was opened up, the wheat belt spread downward from Kansas and the cotton belt spread upward from Texas till the main stream of pioneer agriculture flowed together on our west, leaving the Ozarks an island of land ill suited to the uses of a pioneering people. This is not to say that the region was a desert or unpopulated. But in general the population which did come into this territory tried simply to carry the crop practises of the flat land up into the hills—and with sorry re-

sults, indeed. Though things have largely changed to-day, one may still ride through certain sections and see a native farmer or his wife following a "littie ole rabbit mule" and an eight-inch plow up and down over stony hillsides, which it was a crime even to have cleared. To try and force corn, the small grains (they are cut with a cradle), and cotton from such land is the most thriftless of all ways of employing nature's resources and the labor of human beings. But those very hills are a fine old residual limestone formation, the soil beloved of alfalfa and many of the nitrogen-gathering legumes. It is suited too to raising the finest of peaches and apples and strawberries. The wooded hills furnish splendid pasturage for cattle and hogs and the small creek bottoms will produce an adequate supply of grain and forage for the short winter season. As soon as man makes the nature of the soil and topography his point of departure and not the habits of his past he can fit upon the resources of this region a splendid type of diversified farming, producing a good living to the farm family and salable specialties of a high order.

Similar conditions have existed in the mountain region of the Appalachians and Northeast. The fertile Shenandoah was praised, and backs were turned upon the rough Piedmont sections of Virginia. But to-day the Albermarle pippin and a host of other good fruits, not to mention superior livestock, make the Piedmont a fair rival of her haughty elder sister. So of sheep-raising and horse-breeding on the hillsides of Vermont and New Hampshire, which were once insanely belabored to produce wheat; peaches in the rocky lands of Connecticut, and fruit and butter from the broken portions of New York.

Now all these are well and permit of establishing a prosperous agriculture upon even hilly lands. But they are only the beginning, for as soon as slopes become very steep or the land very much broken even standard methods of orchard cultivation are precluded, and we must fall back practically upon forest conditions, but with the chance for more than a forest product. Here it becomes a matter of selecting tree crops of great value. The Italian gets a cheap substitute for butter from his olive trees and, while we may not alter our habits of consumption to effect such an economy, we have already a substantial olive industry in California. And the high food values of various nuts have been practically ignored in the United States. The pioneer used such products because of stern necessity, but the American farmer has been so intent upon the conventional crops as to think little of the possibilities of nut culture upon those parts of his farm ill-suited to plow methods.

Likewise, he has done no more than passively accept from the persimmon a portion of its spontaneous product, but this is in fact a fruit of considerable economic value and readily capable of improvement. The Department of Agriculture has introduced the large Japanese and Chinese persimmon and they offer a highly promising field of development in the future. From China also has come the Tung-oil tree, capable of producing one of the finest painters' oils from lands otherwise yielding products of small value. Spain is the seat of an important cork industry, but experiments have shown that the cork-oak can be grown upon our own rough lands. And bamboo also presents future possibilities.

And so on indefinitely. The land which was spurned, and very properly so, in the days of our agricultural development can not be unthriftily left in idleness in the coming days when we shall press more heavily upon our natural resources for subsistence. In some cases it is doubtless best to go to the expense needful to render such lands suitable to the products we have been accustomed to raise. In others it can not be done or, if at all, only at too great an outlay. Within the limits set by our tastes (and many of them can be re-educated) it is most economical to humor Madame Nature, to let her produce those things for which she shows a preference or for whose production she is already equipped.

Such an issue of expediency presses itself upon our consideration peculiarly amidst the exigencies already confronting us as a result of war conditions or presaged by after-war forebodings. Capital is being destroyed at an unprecedented rate, and men are being killed and maimed in numbers that can not soon be replaced. And it was upon more man power and larger outlays of capital that all our plans of an enlarging agricultural product were being based. The men and money which might have gone to build great irrigation and drainage works or to furnish the labor, the tractive power, the farm implements, and the fertilizers for a more intensive agriculture are fast being spent upon the battlefields of Europe. How then shall we hope to augment production at the very time when these productive factors are being squandered in a tragic enterprise elsewhere? Through shifting the burden, by every ounce we can, upon that third great member of the economic partnership—Nature; by so adapting our culture as to utilize our natural resources at the peak of their effectiveness; by choosing crops that catch step with Nature's spontaneous endeavors. And what is good policy for war time will be no less effective in adding to our welfare in times of peace.

THE RELATION OF THE STATE UNIVERSITY TO RESEARCH WORK IN WAR TIMES

By Dr. R. W. THATCHER
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A DEMOCRACY is not organized for war. Its aims are those of peace; its fundamental conceptions are those which can result only in peace. When, therefore, war is thrust upon it, a democracy must suddenly readjust itself to new and unexpected conditions. Under such an emergency, it is inevitable that every loyal citizen shall desire to do something to help. This desire manifests itself immediately in proffers of service to the government, and oftentimes in individual initiation of projects intended by the patriotic investigator to yield war-time results.

The first step which democracy must take in war times is to make its government supreme in authority. Freedom to criticize our elected officials is a privilege which seems to be very dear to many American citizens; not less dear is the privilege of employing one's own time and talents in whatever direction he chooses. But in war times, individual ideas and individual preferences must be surrendered to the public good. Successful prosecution of war can be accomplished only by coordinated effort. Coordination can be brought about only by centralized authority.

Modern warfare is essentially a conflict of intelligences. Each side endeavors to outwit the other by the production of new engines of war, of new agencies of destruction, of new plans for defense. All of these demand research of the highest skill, capable of most intense application and of quick and sure results. One of the most important lessons of the early days of the present war was that no nation can afford to sacrifice its scientific workers or break down its research agencies.

The universities, particularly those which have been built up by state and federal funds, are the agencies to which the government has the right to look for research assistance in winning the war. It is essential, therefore, that these universities do everything that they possibly can to maintain their research organization and facilities at the highest possible stage of efficiency. For that reason, I am urging that research

men in our universities be not stampeded by their own individual desires to do some unusual service in war times or by the public clamor for some special war-time effort. The most patriotic service which we can render is to be ready with our laboratories, our shops and our men equipped and working at their highest possible efficiency whenever the government calls upon us for the particular task which it assigns to us as our special part of the national plan.

It takes time for the government to elaborate its plan. Some of us are inclined to become impatient and to desire to turn immediately to some special war-time work. Many voluntary emergency organizations have been formed and hosts of suggestions have been proffered to government officials, doubtless resulting in hindrance if not in positive annoyance in the performance of their war-time duties. My suggestion is that we "sit tight" and perform our regular duties in the most efficient way possible until it becomes clearly apparent what special emergency service each one of us can render to the government.

The government has already organized its research council and its various departments for the prosecution of war-time work. The scientific men of the country and the various laboratories with their special facilities for research have been listed. This constitutes research mobilization. There must necessarily intervene a period during which some units can only "stand and wait" while the general plan of attack is being formulated. If it falls to our lot to wait a little before our particular task is assigned to us, let us not stand idle, but rather keep our equipment well polished and efficient by constant use. It may be that some of us can actually evolve new war-time plans for research which we can pass on to the proper government officials through the National Research Council; but until we are quite sure that our ideas are worth while and likely to serve a national need, let us keep patiently at our regular research problems. We shall then be in position to turn quickly to any emergency task which the government may assign to us on the basis of the work which it knows we are already doing.

Not less important is the careful and thorough training of the young men in our institutions who have not yet been called into federal service. The making of a skilled research worker is a long-time process at best, and we ought at this time to increase rather than decrease our research teaching and, if possible, to speed it up by concentrated work.

Again, while the winning of the war is our present all-ab-

sorbing task, we look forward with confidence to the time when the world has been made "safe for democracy." The necessary reconstruction of our national industry to meet the needs of world food supplies and world industries, as well as to meet the competition of other nations whose skilled energies have been turned to peaceful pursuits, will demand that American men of science be ready, as they have never been before, to match their research skill against that of the whole world. This means constant maintenance of all our research agencies and organizations at their highest efficiency.

My advice and suggestion to individual research workers is, therefore, that we hold ourselves in readiness to undertake any task for which the proper officers of the government call upon us, as the research workers best prepared to do that particular task; but that until that special task is assigned to us, we keep steadily and conscientiously at our regular research work as our highest patriotic duty in these war times.

Turning now to the question of the attitude of the university administration toward research, I should like to say that, in my opinion, the lesson of the war ought to result in a recognition of the rapidly increasing value to the public of state-supported research work. State and federal money has been appropriated in the past for agricultural experiment stations, and more recently for mines experiment stations, and a proposition for engineering experiment stations is under consideration. But the pressure upon these institutions for popular instruction or demonstrations of what is already known of methods of scientific operation of farms or industrial plants has often seriously hindered the development of real fundamental research work. I am not arguing now for better support for that type of research which is characterized by the "seeking after truth for truth's sake," worthy as that may be; but rather for the necessary fundamental research which must be the basis for future industrial development.

Great industrial corporations and various institutions or "foundations" of a semi-public and semi-philanthropic character have recently come to recognize the value of research to the development of the particular industry or cause which they represent. But the general public, as represented by the state legislatures or other public agencies which appropriate public money for specific uses, have been and are still loth to recognize the value to the public of a skilled research scientist. As a result, we have numerous and embarrassing examples of the loss to our universities of many of their most promising re-

search men by reason of too tempting offers of larger salaries by industrial corporations or other agencies such as those I have mentioned.

I believe that the public should be entitled to the results of scientific researches of the most skilful kind, and that the benefit of such work ought not to be limited to private use or available only to private gain. For that reason, I feel strongly that our universities, and the public agencies which provide the funds with which they are to operate, ought to recognize the immense value to the general public of the unselfish service which the research men of our university staffs are rendering, but which they can not be expected to continue to give to the public if they are continually offered higher salaries and better facilities for work in privately supported or endowed laboratories. Such recognition should have come even if the war had not intervened; but it is doubly due now that the war-time emergency and the necessities of reconstruction work after the war have so emphasized the necessity for and the value of scientific research work.

SNOW AND ITS VALUE TO THE FARMER

By Dr. ANDREW H. PALMER

U. S. WEATHER BUREAU

SNOW falls everywhere in the United States except in certain portions of Florida and California. The amount which falls each winter varies greatly in different parts of the country. It ranges from little or none along the coast of the Gulf of Mexico to more than 500 inches in the high Sierra Nevada Mountains. In the more densely settled eastern portions of the United States it ranges from 10 to 50 inches, and measurable amounts fall on from 10 to 50 days of the winter half-year. Here the proportion of the total annual precipitation (rain, snow, hail, sleet, and dew) which occurs in the form of snow ranges from 10 per cent. along the Atlantic coast to 20 per cent. in the vicinity of the Great Lakes. The amount of snow which falls at any particular place also differs from year to year. Some winters are almost free from snow, while others bring abundant snowfall. In the elevated portions of the West, nearly all the precipitation occurs in the form of snow, partly because the summer half-year is comparatively a dry season, and partly because of altitude above sea level. The principal controls which determine the amount of snowfall at any place are the winter temperatures and the amount of moisture in the air.

Snow as it falls averages about 10 per cent. water by volume. In other words, 10 inches of newly fallen snow are usually equivalent to 1 inch of rain. An inch of rain simply means the rain contained in a layer of water 1 inch deep uniformly distributed over the ground. This is equal to a little more than 100 tons of water to the acre. However, falling snow varies greatly as to density, "wet snow" containing relatively more water than "dry snow." Immediately after reaching the ground snow begins to settle, and in the course of time its density is increased to three or four tenths that of water. That which has been subjected to alternate freezing and thawing, or that which has been compressed by the weight of overlying snow often approaches the consistency of ice. The settling pro-

A Cottage in the Snow.

ceeds regardless of whether the air temperature is above or below freezing (32° F.). When the temperature is below freezing, gravity alone causes the snow stratum to become more compact, without loss of its crystalline structure. When the temperature is above freezing, melting begins at the surface of the snow, the resulting water percolating through the underlying snow to the ground beneath. There is usually a lag in time between the beginning of melting and the first run-off.

Under conditions favorable for plant growth the moisture contained in a soil of uniform texture is about 25 per cent. of the volume of the soil, broadly speaking. But the maximum capacity of such soil for water ranges from 30 to 50 per cent.

Photograph by Fred Rath

A Cottage shrouded in a Mantle of White. To most people snow suggests extreme cold. However, the woman here shown does not appear to suffer from cold, in spite of the frigid environment.

Photograph by Fred Rath.

JANUARY IS A MONTH OF RARE DELIGHT ON THE FARM.

of its volume. Though they show little uniformity in texture or in water content, most soils, under ordinary conditions, can absorb additional moisture. When snow falls upon unfrozen ground it may keep the surface soil from freezing. The snow cover checks the loss of heat through radiation, while some heat is received from below. If such a cover persists throughout the winter the soil may remain unfrozen, and, if so, it will readily absorb water when the spring thaws set in. When an unsaturated soil freezes it is relatively porous, and can absorb moisture as unfrozen soil can, but at a slower rate. When snow that has fallen upon frozen soil melts, a larger proportion of the resultant water is lost through run-off than occurs following the melting of snow lying on unfrozen ground.

Though the root systems of most annual crops are limited to the first foot of soil, the underlying three feet serve as a reservoir from which they derive much of their sustenance. It has long been recognized that water is wealth, and that the water supply of a country is an important part of its agricultural capital. In one sense this part of the capital is administered

through the first four feet of soil and subsoil, where water moves freely in capillary action. Snow conserves as well as replenishes this soil moisture during the winter season.

The Significance of Snow to the Farmer

In cities, snow probably does more harm than good. It makes walking difficult, delays transportation, and interferes with wire communication. In great cities like New York, Chicago and Boston the cost of removing snow from the streets amounts to hundreds of thousands of dollars every winter. To the farmer, however, snow is an asset, not a liability. Although it does make roads impassable until "broken in," and although in the plains of the West a heavy fall of snow temporarily cuts off the food supply of grazing cattle, snow may rightly be considered an agricultural resource. "A snow year, a rich year," says one proverb. An enumeration of some of the more important factors showing the great value of snow to the farmer follows.

As a protective covering or blanket, snow serves very much like leaves or straw, only in a lesser degree. Frost in the ground is simply capillary moisture which has been congealed by temperatures below freezing. Frost will penetrate to a greater depth in newly plowed land than in a pasture. For the

The Marvin Shielded Rain and Snow Gage, used by the U. S. Weather Bureau to Measure Snowfall. The curved plates forming the sides eliminate the effects of wind currents, thus permitting a true "catch" of snow in the enclosed cylinder.

Photograph by Fred Rath.

ABANDONED TO WINTER—A COTTAGE SUBMERGED IN SNOW. When deep snow like that here shown melts, much of the water soaks into the ground.

same reason it will penetrate deeper in bare than in snow-covered ground. The protection afforded by the snow results partly from the snow forming the covering and partly from the air associated with it. Experiments have shown that a 2-inch covering of snow will reduce the daily heat exchange between the earth and the air above it almost one third, and that a 4-inch covering will reduce it about two thirds. For example, in an investigation which extended over a period of about eight days, during which the extreme range of the air temperature amounted to 34°, a thermometer 2 inches beneath the surface of the snow showed a range of 25°, one at 4 inches a range of 14°,

COTTAGES ALMOST SUBMERGED IN SNOW.

one at 8 inches a range of 3°, and one at 12 inches a range of but 1°. No range in temperature was observed at the bottom of a 24-inch cover of snow. Moreover, there was a distinct lag in the time of maximum and minimum temperature as the depth of the snow cover increased. It was found that it took 12 hours for the cold to penetrate the 12-inch cover, causing the lowest temperature to occur there at the time of the highest temperature in the open air, and *vice versa*. The diurnal heat exchange in deep snow on the ground is only about one half that in a grass-covered meadow, and about one fourth that in bare sandy soil. Furthermore, it is twice as much on clear as on cloudy days. The denser the snow the poorer it is as a pro-

Photograph by Fred Rath.

THIS PICTURE, TAKEN IN THE MOUNTAINS OF CALIFORNIA, SHOWS SNOW WHICH UPON MELTING WILL FURNISH IRRIGATION WATER FOR THE FERTILE VALLEYS FOR WHICH THE STATE IS FAMOUS.

tector. Loosely packed snow containing much air mixed with it serves as the best blanket. Besides being a poorer conductor of heat, and therefore a better protector than ice, loose snow permits the respiration of submerged vegetation, which proceeds even at temperatures far below that at which actual growth is possible. Grass and grain are sometimes smothered when the snow, through alternate thawing and freezing, is converted into ice.

Besides serving as a blanket which checks the loss of heat from the ground either through conduction or radiation, a cov-

ering of snow prevents evaporation from the soil. Soil moisture, conserved and replenished by the snow, is thus made available to the roots of trees and perennial plants during the cold season, when little rain falls. Moreover, such a cover prevents the violent winter winds from tearing the dormant vegetation. Furthermore, snow permits the penetration of some light, and recently it has been recognized that light can replace heat to a considerable extent in the various processes of vegetation. Again, it is known that killing from cold is due to the removal of water from the plant protoplasm, the freezing be-

LAKE SPAULDING, AN ARTIFICIAL RESERVOIR IN THE HIGH SIERRA NEVADA MOUNTAINS OF CALIFORNIA. Water from melting snow collects in this reservoir and is subsequently used for irrigation and power purposes.

ing largely intercellular. A plant's ability to withstand cold depends in large measure upon the capacity of its cells to give up water without injury. In most kinds of vegetation, and particularly in winter buds and woods, a rapid fall in temperature requires that water be given up faster than the plant cells can afford to lose it, the result being serious injury or death. As a means of checking this rapid decline of temperature, either in snow-covered branches of trees or in snow-covered vegetation on the ground, another value of snow is easily recognized.

Snow has aptly been called "the poor man's manure." The reason is obvious. Melting snow moistens the soil gently and gradually without condensing particles by pounding them and without floating up any clayey mud to the surface to encrust the land when it dries. Rain compacts the surface soil, but snow and frost loosen it. Alternate freezing and thawing mellows the soil. When water freezes it expands. The expansive force is

SNOWBOUND.

very great; it is sufficiently powerful to break up and to crumble solid matter with which it is associated. This is the reason why coarse lumps or clods of soil fall apart in the spring. For the same reason marl strewn over the surface of the ground in the autumn becomes a powder before spring.

Snow also checks the run-off when the temperature is low. Ground water is replenished more easily by the melting of snow, or by rain falling on the snow, than it is when an equal amount of rain falls upon bare ground. Moreover, the bene-

HOUSE IN THE SNOW.

Photograph by Fred Rath.

ONLY THE CHIMNEY OF THIS COTTAGE CAN BE SEEN, THE REMAINDER BEING SUBMERGED IN SNOW.

ficial effects persist longer. Snow is not melted by cold rain as readily as most people imagine. Dry winds, direct sunshine, and high air temperatures are much more effective.

As a source of moisture snow is perhaps less important than rain, generally speaking. However, in the western portions of the United States the winter snows furnish practically all the water used for irrigation and power purposes throughout the year. Fortunately, the snowfall in the western moun-

Photograph by Fred Rath.

A RAILROAD CANYON IN A REGION OF EXCESSIVE SNOWFALL.

tains is abundant. Packed by compression, as well as by alternate freezing and thawing, great banks and drifts of snow solidify to ice. Slow melting follows in the spring and summer, the resulting water collecting in natural and artificial reservoirs to form the only available summer supply.

In various other ways snow is valuable. Just as transportation by water involves less waste of energy than by rail, so it is easier by sled than by wagon. There is smaller loss of energy due to friction and to wear and tear. Logging and lumbering, as well as the transportation of bulky and weighty quantities of grain, wood, coal and ice, could not be accomplished easily without the snow. A snow cover prevents the occurrence of prairie fires. Forest fires are least likely in midwinter, for the same reason. They usually occur during the spring, summer and autumn months, when vegetation is dry, and there is little to check the spread of a fire once started. Moreover, snowflakes remove certain microbes (disease germs) and dust particles from the air through which they fall. For this reason water derived from the melting of snow which has fallen in or near cities is not fit for drinking purposes.

Photograph by Fred Rath.

BRANCHES OF TREES HEAVILY LADEN WITH SNOW. (Note the railroad snowsheds in the background.)

SNOW AND GRASS.

Every farmer has observed that a good hay crop follows a winter of abundant snow. After such a winter the subsoil is

Photograph by Fred Rath.

MIDWINTER IN A WESTERN MOUNTAIN VILLAGE.

almost saturated. Moreover, grass is easily injured by alternate freezing and thawing of the soil moisture enclosing its roots, but is greatly benefited by a snow cover which persists throughout the winter. In the expansion which accompanies the freezing of moisture in the surface soil the grass roots are torn and heaved out. For this reason pastures are soft in the spring. Lawns and pastures are improved by spring rolling, which presses the roots back into the soil, forming a firm sward. Loosely packed snow is an ideal winter cover for all kinds of grasses. However, if the snow is solidified to ice by frequent winter thaws and subsequent freezing, the roots may be smothered.

SNOW AND WINTER WHEAT.

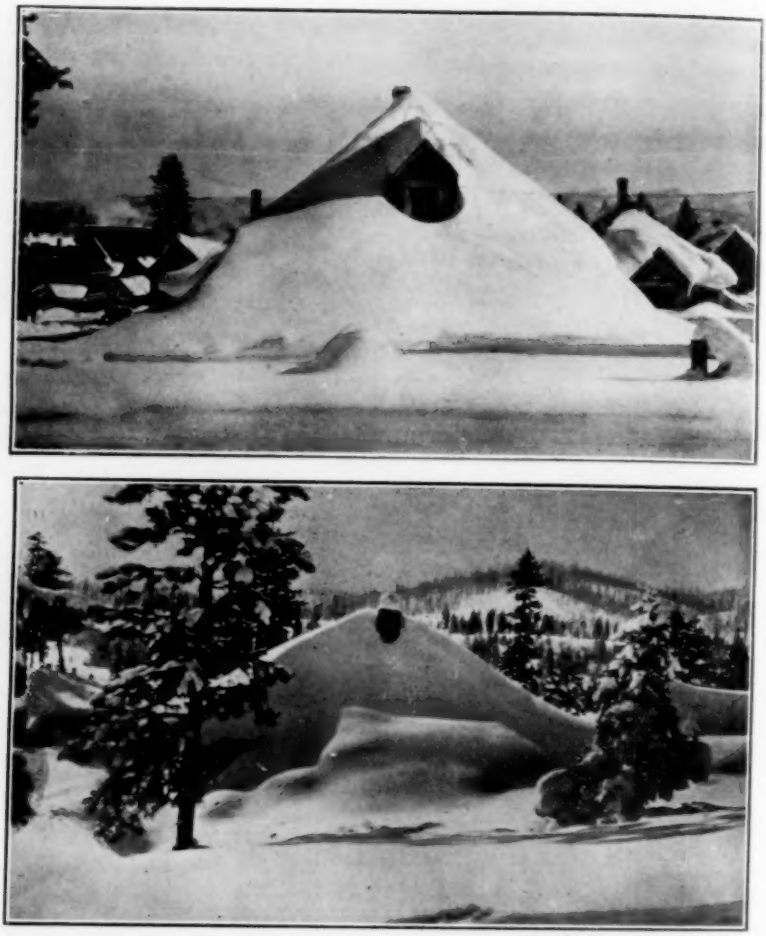
The beneficial effect of snow is perhaps more readily apparent in the case of winter wheat than in any other crop. Wheat is normally a winter annual, and climate is its most important control. It requires a temperature of about 40° F. to germinate, and while it does not grow at a lower temperature, the plants inhale oxygen and exhale carbonic-acid gas throughout the winter. Cool weather and considerable moisture are required during its early growth. The weather conditions prevailing during the winter months determine its density of growth, and therefore its yield. The plumpness, quality, and color of the grain are determined by the warmer and drier part

of the year, when the crop ripens. The importance of snow in the early growth of winter wheat is paramount in regions where the winters are severe. Snow acts as a protective cover against temperature extremes, wind and evaporation; it permits the penetration of light and the respiration of the plant tissues; it supplies the necessary winter moisture; and prevents the tearing and the heaving out of the roots by the alternate freezing and thawing of the soil.

More than two thirds of the winter-wheat acreage in the whole United States is included within the eight states of Kansas, Nebraska, Oklahoma, Missouri, Illinois, Indiana, Ohio and Pennsylvania. In this belt the winters, though moderately severe, usually bring sufficient snow to protect the crop. On the other hand, more than five sixths of the spring-wheat acreage of the country is included within the three states of North Dakota, South Dakota and Minnesota. In this belt winter wheat is not produced on a large scale, principally because ordinarily there is insufficient snow to protect such a crop during the severely cold periods which occur almost every winter.

Photograph by Fred Rath.

IN A REGION OF EXCESSIVE SNOWFALL.



Photograph by Fred Rath.

DWELLINGS ENSHROUDED WITH SNOW.

SUMMARY.

To the farmer the benefits derived from snow far outweigh the disadvantages. As it falls, the density of snow is about one tenth that of rain, but upon lying on the ground it soon acquires a density of about three or four tenths that of water. Under certain conditions it may solidify to the consistency of ice. As a blanket or covering, snow on the ground checks winter killing. It protects vegetation from extreme temperatures, from excessive evaporation, and from destructive winds, at the same time permitting the penetration of some sunlight, and

Photograph by Fred Rath.

RAILROADING UNDER DIFFICULTIES IN THE WESTERN MOUNTAINS.

allowing uninterrupted respiration of plant tissue. On twigs and buds it conserves cellular moisture which otherwise might be sacrificed at too rapid a rate during sudden changes of temperature. It mellows the soil, replenishes the ground moisture, checks the run-off from winter rains, furnishes most of the water used for irrigation and power purposes, provides an easy means of transportation, and prevents destructive prairie and forest fires. Grass is benefited by abundant snows, and winter wheat is largely dependent upon it for its success. All in all, the recurring snows of winter form one of our most important agricultural resources.

THE B.A. DEGREE IN AMERICA

By Professor A. G. KELLER

YALE UNIVERSITY

IT requires no very great hardihood to assert that the B.A. degree, in this country, has been cheapened to the verge of meaninglessness. The degree has been so lavishly conferred, and for such a variety of accomplishment, that the letters after a man's name mean nothing of any importance—unless, perchance, they are followed by a parenthesis enclosing the name of the conferring institution. Even then, that for which they stand, let the institution be of the very best we have, is not crystal-clear.

And there is not much stress, despite the efforts of the Carnegie Foundation, in the direction of improvement. Engineering degrees, and the M.D., tend to keep themselves up, because they touch more intimately and vitally upon definite and concrete human interests. The bridge breaks down; the patients die—here is a sort of inevitable test that checks up results and imposes stress. Results are verifiable. But the B.A. is far removed from such tests—farther, perhaps, than any other degree in course. People have nothing definite that they expect from a B.A., whereby they can judge whether any standard has been reached or not. Nor yet has any college known to the writer a set policy in regard to the degree, so that outsiders, on examining its product, can decide whether it has succeeded in its business or not.

I am not about to try to prove the above assertions. I take them to be self-evident to any one who has thought, or chooses to reflect, upon the situation. I wish, rather, to put a query.

Suppose that an endowed college sets itself the question of making a B.A. course which will stand for something so valuable that it will be glad to have its special guarantee-mark in the parenthesis after the letters—so that it will be as jealous of that mark as a high-class firm is of its trade-mark. Suppose it says: "The 'B.A. (Weissnichtwo)' shall stand for quality." Suppose, that is, that this college wants to adopt a definite policy with respect to the B.A. degree. What shall it do?

There is one very simple and easy answer: get all good

teachers, and no poor ones, and sit tight. But this can not be done. Most colleges have a number of poor teachers—whom almost any one would regard as such—attached irretrievably to the faculty; and even if all the poor ones would conveniently resign, still their places could not be filled with good ones. The market doesn't hold enough of them. And, of course, there would be at once a difference of judgment, except in the extreme cases, as to what a teacher should be. To this latter point I shall return. For now, all that can be done as an approach to this counsel of millennial perfection is to make no future whimsical or snap-appointments—to be fastidious to the last degree, according to what lights and conscience we have, in the selection of members, and particularly permanent members, of a faculty. Also there should be such discipline in a faculty that inefficient or conscienceless members should be under pressure to do the best they could. If, even as faculties are now constituted, every one did the best that was in him, the case would not be anywhere nearly so bad as it is. This too may seem to be a utopian suggestion. But it helps to set the case before us. Let us now return to our query, modifying it to read: What *can* a college do in the construction of a B.A. policy?

No college can pluck figs from thistles; nor yet can it, however ineffectual its offerings, make thistles out of figs. The sort of students that come to it represent a constant element in its showing and destiny. Nothing worth while in the way of a system or policy is possible until punctilious account is taken of the material to which the B.A. process is to be applied. This is one of those perfectly obvious things that some professors chronically ignore, thus bringing a connotation into the term "academic" that is far from flattering.

In the case before us, this constant is the young American of eighteen to twenty-two, or thereabouts, who comes to our colleges. It seems almost a triviality to say that he is the product of his social environment, and that he can not be made otherwise without first altering that environment—certainly not by yearning over him or vituperating him because he is not like the English, French or German lads. Of course he can be treated in a course so that he will avoid that course, as is demonstrated within every college by certain teachers who gradually clear their courses of undergraduates. From any sane college standpoint, such "instruction" can not be approved. No artificer amounts to much who can not or does not take the trouble to know his materials.

What are the outstanding qualities of this human material? Said an eminent scholar of foreign birth and training, regretting the very course of unremitting attention to study in boyhood which had perhaps made him what he was—upon which, at any rate, an American colleague was commenting, to the disadvantage of American methods: "Yes. But I had no youth. I had no youth." Perhaps this remark made some impression upon the colleague. I do not know. But it offers us a starting-point from which to envisage the American lad. He is having his youth. It makes of him this and that which is revolting to an elderly soul. It is hard sometimes to have patience, even if one has not forgotten his own youth. But, after all, what a wonderful thing youth is, as it recedes from one who has lived it with gusto! Would he have it abolished in favor of a precocious seriousness of maturity? It should be listed as an evidence of kindly design in the universe that, in this country at least, that can not be done. In any case, here is a constant factor, to be reckoned with, molded somewhat if desirable and possible, but not inveighed against.

One of the chief complaints about the student is that he does not know, early in his course, what he is going to do when he leaves college. If he did, he could then specialize and quit "trying," ingenuously, or disingenuously, this and that. Well, most of them do not, with telescopic or prophetic eye, view the vista of their futures. Their life-status, in America, is not settled soon enough. There are no cut-and-dried careers to which they are, as it were, preordained. So, too, they are not set off into life-status or class; it was partly to get rid of such Old-World inflexibility that people have migrated to this country. We have no "careers" for which an undergraduate, studying non-professional branches, can fit himself. In other words, the social environment in the United States is such as not to call for early specialization in a regular college, and so it does not occur. There are professional schools for that. And even these are coming latterly to demand an antecedent degree of the B.A. order, as something, vague and uncertain, perhaps, but yet indispensable before strict specialization. The directors of such professional schools—which are the most noted ones—seem to see something useful in the colleges, even as they are. What they want, of course, is a clientage of liberally educated men; if a doctor or a lawyer knows only medicine or law, he is at a discount in these days. The doctor has an increasingly significant social function. Even the soldier, as the recent changes in the West Point curriculum indicate, ought to know some English and history.

As a matter of fact, a very large proportion of college graduates go into "business." Now there is no form of specialization for this career except in a business college. Academic courses in economics are not meant to teach a man how to be a bank-teller or how to buck the stock-market. If professors could teach business, they would be likely to show more evidence of having practised it, on the side, instead of constituting a chosen mark for promoters of all sorts of doubtful ventures. What the business-man-to-be wants out of college is a cultivated, adaptable mind and widened interests, so that there will be something in his life besides business. He needs a liberal education. Plenty of men in college know that they are going in with their fathers, or they have positions otherwise in view; but they do not want to specialize, or they would not be in college. No matter what they came there for, it was not to become business specialists, or any other sort of specialists; and they constitute a proportion that has steadily grown ever since the time when going to college and doing pretty well generally meant entrance into the ministry.

Here are some facts about students, as they are. Anybody who knows the student knows they are true; and any one who does not know him, as he is, not as a figment of a prepossessed mind, has no business to be talking about the matter at all. It is a detriment to education when such men get into positions which seem to lend them weight in counsel, so that they can impress outsiders, oppress their colleagues, and at length depress the reputation of all education by attaching to it, again, as their talk is seen to be futile, the connotation which "academic" has come to bear.

The "liberal education" of which I have spoken is not specialization. It is selection. It is a process of "discovery of mind," as one efficient teacher phrases it. This discovery is consummated by "exposing" the as yet unoriented, or even unformed mind, to certain influences. The youthful mind does not take to this process as a duck to water, by any means. A veteran teacher once remarked that he had never ceased to marvel at the infinite capacity of the human mind to resist the introduction of knowledge. Hence the need of "school-mastering," where that means effort in the opening of minds and the rendering of them sensitive, and in the imposition of discipline. If the education is to be a "liberal" one, this "exposure," in many directions and to a variety of intellectual influences, must be accomplished, though it has to be forced. No matter what a student comes to college for, this "exposure" should take place,

and this "discovery of mind" should be accomplished—or the student should leave college. It is freely granted that the life among one's fellows, at college, possesses educational value of the highest order; very likely the athletics and the rest of the "extra-curriculum activities" have their sort of educational value. But the faculty can not take cognizance of these except to exult over or regret their presence. The B.A. degree stands for things of the curriculum. In any respectable college the passing of the courses, together with the maintenance of a certain conventionality of behavior, is the *sine qua non* for the B.A. degree. Considering the nature of the student, what should the B.A. stand for, intellectually? What should the curriculum of studies be? What is a "liberal education," in these days and in this country?

Education is the transfer of knowledge, rules of living, discipline, etc., which makes the young into fit members of society —fit, that is, to take the places of the passing generation. Being that, it is different in different societies—Zulu, Afghan, American, English, German. All schools aim at this; the graded schools try to inculcate what they consider the absolute essentials, for those who can not go very far. The high schools aim at a fuller preparation for life in the local society. And then come the colleges whose product is, or was once, at least, supposed to constitute a class competent to grapple, with knowledge, discernment, and trained and disciplined mind, with any and all aspects of social life. We know that this reputation was never deserved; but at least the college graduate was supposed to have had the chance, whatever he did with it, of making the acquaintance of all forms of knowledge. He was a man who had had opportunities beyond the common range of men for knowing about the questions that have always engaged the interest of man. He had had the chance to know what was worth knowing.

Not so very long ago the stock of human knowledge was much smaller than it is now, and the idea of what was worth knowing was a traditional matter. Both of these facts contributed to a prescribed course of study. Rightly or wrongly the college degree meant something definite: Latin, Greek, mathematics, metaphysics, etc. Every one had to take pretty much the same course; and he had to study certain subjects, whether he wanted to or not, or he might leave college. If any one wanted the B.A., he could present certain fixed prerequisites and pursue study on lines laid down. He could take it or leave it; and there was no control exercised over the college by the

lower schools. There were numerous advantages in all this. At least the B.A. course had the dignity of its convictions.

But it was not adaptable. There was too little room for variation and new selection, with consequent adjustment to environment. And so the old required college course came to be out of joint with the times. Its inertia of tradition prevented it from seeing any good in the newer disciplines. Its self-sufficiency stirred such powerful opposition and criticism as is typified in Herbert Spencer's classic work on education. The resistance it offered caused the gathering forces of the new time to carry the college course out of the hands of these who had been its natural directors virtually into the hands of the students themselves. The elective system secured freedom from tradition; but this freedom was not that sole kind of liberty that ever benefited the race—liberty under law—but ran out into license and abuse. Doubtless the reaction was perfectly normal, in view of the entrenched conservatism of the old curriculum; those in charge of the colleges, who resisted the new, brought all their woes upon themselves. But it was entirely irrational, and cheapened the college and its degree, to leave the course of study to the untrained and often whimsical (when it was not a super-expert) choice of a lot of boys.

It was not that the old course was a required one that brought on its collapse under assault; it was the nature of the requirements, and of the exclusions. New forms of knowledge were on the increase, and, in particular, science was coming to be the feature of the age. If education was going to fit the young to live in the society of the time, it could not stick to the old course and look with contempt upon the characteristic intellectual activity of the epoch. By trying to do this, it proved itself maladaptable and was selected away. This was inevitable; the old education was suffering from a sort of "spinescence" and could no longer adjust; and so the board had to be swept clean, for a new deal.

No cataclysm of this order can occur without loss of much that is good. As I have intimated, we now see that the old system had its parts. We can never go back to it again—*Was vergangen kommt nie wieder*—but there is no reason why we can not, now the surge of the reaction against it is past, and it is dead forever, reintroduce some of its best features.

I have said that the old required course did not fall because of the requirement, but because of the course. The element of requirement was swept away along with the course, in the rush of reaction and of resentment. Then came the confusion of the

two; requirement of anything became anathema, and freedom was the watchword all along the lines. The elective system reached clear into the elementary schools, as an inundation, having once risen to surmount its first barriers, goes coursing up the country toward the foothills. But sensible people are now coming to see the folly of such extremes, and to awaken to the fact that the college course, like any other course of learning, should be laid down by men of experience and perspective, not by boys who lack both. If those who have tried to direct the studies of the youth had not ignored the nature of the material with which they had to deal, as certain savants whom I have noticed still wish to do, the axiom that any course of study, whatever it may be, should be required (and should be so difficult as not to be chosen voluntarily by the ne'er-do-well) in order to be effective, would long ago have been generally admitted.

I believe firmly in a required course of study, therefore; though I premise that it is to be laid down by men of experience with students of all types, and who have attained a perspective, not only of studies, but of the life of the society into which the students are to be *per gradus* inducted—"graduated." First of all, therefore, I think that a college wishing to adopt a policy regarding the B.A. degree, should move straight toward a required course. If the student insists upon choosing, let him choose between colleges—there will always be some that allow him "freedom." But having chosen to try for our sort of B.A., which we are striving to make distinctive and distinguished, let him plan to do but little more choosing. We will take the responsibility along with the power, and stand or fall by our results. Of course this takes some nerve, and means that we bid defiance to the prevalent cult of numbers. We may even become poorer, for a time—though, if we carry out our plan we shall presently have candidates, as one man put it, "yammering at our gates."

I said that the student should do little more choosing. He should do none that would allow him to evade a certain "irreducible minimum" of requirement. Now, what will this irreducible minimum be? Naturally, the very essence of essentials. In a word, it will include what a thoughtful mature graduate is glad he had, and does not see how he could have spared, plus what he regrets that he did not have, in his own college course. Putting together the experiences of such men, experiences of which I know, I find that a collegian should make the acquaintance of all of the several characteristic disciplines included in the curriculum of any college of the better sort. One man I

know, reared under the old régime and rebelling in no pronounced way against it, graduated without knowing any natural science—knowing no astronomy, chemistry, biology, physiology, embryology, geology, or botany. He had no course treating of the greatest single factor in modern scientific thought, Darwinian evolution. I am speaking only of disciplines to which he was not "exposed" at all. There were some courses which he took that were rendered useless to him because taught so poorly as to be repellent, or because they were unsystematic, or (even at that time) arranged for the budding specialist. In a number of lines, therefore, including some in which he had courses, he was not sent out of college ready to understand, as a liberally educated man should, many of the most significant things in the life of the society within which he was to live and labor. In certain lines he has had to acquire, by considerable exertion, the elements of sciences related to his own special work and necessary to him. With all these hiatuses in his fit, he was not a liberally educated man. He will never be that now, for life seizes one and works him and wearies him, and the power of acquisition, and the time for it, fail.

Others whom I know pursued science more especially, in the time they could win out of the old classical schedule, and do not show the painful lack of it indicated above; but they have a similar ignorance of modern language, let us say, or history, or literature. They feel these lacks and have as strenuously labored somehow to make them up, as my other friend did in the matter of science. They were not liberally educated, because they had had little but science; he, because he had had almost no science.

It is a common saying of the advocate of specialization that any defect incurred by devoting attention almost solely to one thing will be automatically remedied by the youthful specialist, who has thus learned application and seriousness of purpose. I do not know where the evidence for such a view is to be found. I recall cases used (prophetically) in point, but, viewed after the act, they did not pan out. As a matter of fact, such a specialist will remain narrow unless he is an extraordinary personality who will react against the unwisdom of his course and see its straitening effect. As for the ordinary man, he will never do this, but will live on to constitute one of that pitiful band of the half-educated who think they know it all, or will be one of those who feel all their lives the lack of a rounded equipment. There is no time later to get these things up; a more advanced age rebels against the drudgery; and no amount of

mere reading can take the place of a skilful introduction and guidance through the elements. Few will begin Greek with the excellent Balbus at seventy, or even late in middle life, as Huxley did. These things are like the diseases of children: taking them betimes is best; with adults they go hard.

Returning then to the idea of general "exposure" of the mind to cultural influences as represented in college courses, it is understood that we want all the influences, not one alone, to "take." Let one predominate after a while, if fate wills it; but see to it that there is a proper exposure to all. For one thing, you can not be sure which is the real infection till all are conscientiously tried. One influence, coming a little later, may easily be prepotent over another which looks to be the real and lasting thing until the all-compelling factor enters the field. Frequently it is a subject not encountered till senior year that proves to be the really engrossing attraction. Every such possibility should have had its chance before college is over. By that time the conditions for an intellectual orientation should all have been met, and even the totally "non-specializing" student should have selected his intellectual hobby—so blessed a thing to fall back on, "mid this dance of plastic circumstance." A sane choice of intellectual interest can not be made on the basis of mere whim, fancy, or vague yearning. I can recall a graduate student whose first idea was to write a thesis on the relation of God to the universe; but who, advised to look about a while first and study things, ended by producing an excellent dissertation upon the metal-industry of a small eastern town.

It will be observed that we are working around to the conception of the liberally educated man as one who knows enough about all the different major intellectual disciplines to have developed an intelligent special interest in one or more of them. If a student is obliged to become really acquainted with the essentials and methods of a variety of disciplines, he is almost sure to develop a fondness for some one of them. There are not a few busy men who take pride and pleasure in pursuing as they can some line of intellectual activity utterly disconnected with mere business; and this keeps them interested and interesting. Such men reflect great credit upon the college they attended; and they live happier lives. But this even semi-specialization is only a by-product of the B.A. policy here advocated, which would, as its paramount function, hold every student to a required course including the elements and essentials of all the major branches of knowledge or mind-cultivation taught in the better colleges. Let us get down nearer to par-

ticularization as to this policy, which aims to turn out well-rounded men rather than specialists or even hobbyists.

It goes without the saying that no man is well rounded who is graduated ignorant of science and scientific method; or without development on the side of the literary, or the esthetic in general. I think it would generally be admitted that the graduate should be able to read freely some language beside his own. Dispute might rise as further attempt to particularize is made. Somebody might object that one need not take both physics and chemistry, both geology and biology, both an ancient and a modern language. I suppose, however, that no one would deny that it would be better if all of these could be gotten. If, now, we scan the list of departments or subdepartments represented in the catalogue of some good college, we are surveying a classification of intellectual disciplines—a classification for the most part automatically evolved, of disciplines regarded as sufficiently typical in content and method to be set off one from another. Let us see whether such a classification, developed for ends quite other than those of this essay, can aid the present inquiry at all.

In general, there are about a dozen categories that might be considered as representing major divisions of human knowledge as taught to undergraduates: ancient language, modern language, English, mathematics, physics, chemistry, biology, geology, psychology, history, philosophy, economics, sociology. Suppose a man of twenty-two to be familiar with the general content and method of the above disciplines; would he not be a liberally educated man? Would he have the regrets at the hiatuses in his education of which I have spoken?

"No!" roars the specialist-lover, "he would not be educated! He would have a smattering of a lot of things, and really understand no one of them! Out upon him for a shallow taster!" Well, even so, would he not be better off, in his claim to be liberally educated, in his right to the B.A., than a man who had taken a strictly special course, and to whose amœba-saturated head any thought, say, of the essential nature and the evolution of human society was foreign? To whom the names of Homer and Goethe, and Caesar and Bismarck, were mere vocables?

But let us pass this instant and *ex parte* objection by for the moment, in order to get clear upon two preliminary matters, one of which conditions the other. First, is such a scheme practicable? By a simple calculation it is seen that if each discipline cited above were allowed a three-hour course for a year

in which to treat the essentials of its being, the sum of the hours would be thirty-nine (out of the usual sixty required for the B.A.). This sum could be reduced somewhat if "exposure" had already taken place—say, by four years of Latin—before coming to college; but it would also have to be increased somewhat in the case of certain disciplines begun later or covering much ground, as, for example, the social sciences or history. Forty-five hours at the outside, that is, three-fourths of the college course, ought to do the business for any one, leaving fifteen for following up certain disciplines, to attain a more intensive knowledge of them. A boy well-prepared or "exposed" at entrance would automatically, and properly, win a larger scope of election; for he would have much more than fifteen hours free. The essentials acquired, there might then be some choice, though it should not extend beyond going on with some stock course deliberately laid down by the department in question as the next vital step in acquiring the next most important things. Rambling should cease, under this system.

But I hasten to the objection now for some seconds on the lips of some readers. "From our elementary courses the student can not get the essentials or the perspective." This is true. The nature of many elementary courses, as now given, would have to be changed. Some departments always look at the elementary course as the first step toward making a specialist, and put forth no effort to get the essentials of the discipline before the student; he will gradually, doubtless—at least, it is to be hoped—soak them in as he goes on in his specializing. This attitude seems highly unwise if it is deliberate, and inexcusable if it merely represents laziness or lack of interest in beginners—a lack generally conspicuous in the specialization-champion. Nothing impresses youth so much as catching glimpses of vistas and perspectives, as he works through a tough undergrowth. It gets his interest aroused; and that is good, even for the future specialist. But we have seen that most college students have no idea of becoming specialists. Hence the conduct of an elementary course on that assumption is a basic error. A change here would be, in any case, an advantageous adjustment to actual conditions.

And then there are other elementary courses which are loosely constructed, and in connection with which there has been no attempt at all to get down to essentials—not because the idea here is specialization, but because there has been no pressure on anybody to determine what the essentials are.

Who can deny that it would be a blessing for any department

to have to take thought and be resolved as to what essentials in its line are? To "get down to brass tacks"? To clear decks for real action? Courses, as well as departmental schedules, get cluttered up with curios, antiques, and bric-à-brac, whose function is chiefly to obstruct movement and collect dust. The "irreducible minimum" to which I have alluded is what is left when these are cleared away; and it is just what the student most needs. He can be a liberally educated man if he has not read the "Castle of Otranto," but not so if he is innocent of acquaintance with "Hamlet," or "Paradise Lost," or "The Idylls of the King," and can not write clear, idiomatic English. He may be able to calculate the sort of sound waves emitted by an organ-pipe, but if he does not know how a barometer works, his physics has failed him. He may have dissected dozens of frogs, but if he does not know his Darwin and his Huxley, he is not (biologically) liberally educated.

The elementary course, required of everybody, should be a candid answer to the question: What shall here be given that the student may see the characteristic sphere in the world of learning and living ocupied by this subject?

I hear the phrase "information course" echoing back to me from one of my earlier paragraphs. But what must come first; which is more elemental, even if also more elementary: facts, or syntheses and methods? Said an elderly lady, reflecting upon her schooling:[1] "I have sometimes thought that historic research would be easier for me if sometimes I knew what men did before I was forced to understand why they did it." It is the fact that is primordial, and upon it mental operations spend themselves. Many courses in economics fail because the students do not know the economic facts—say, the difference between a stock and a bond—upon which the structure of theory rises. I maintain that it is no aspersion upon a college course that it is "informational," provided the information is true and to the point. What the beginner needs, whether he is going to specialize or not, is sets of data, classified and interpreted according to the accepted theories of the discipline in question. The theory-end, admittedly, has to be in the main dogmatic, ignoring exceptions for the time; for the crucial desideratum is a foothold, a *point d'appui*. But the American student is not docile to the extent of following blindly wherever he is led. He is strongly practical, like the nation that nurtured him. He must needs see the relation of what he is doing

[1] Winifred Kirkland, "An Educational Fantasy," *Atlantic Monthly* for August, 1915, p. 237.

to human life and interests. The great figures in the teaching world have always related studies to life. If such a relation can not be compassed, it means either that the study is an unearthly phantasm or the teacher is a misfit or is at fault. Much that goes under the designation "information" is really illustration, calculated to fix a point or set of points by relating it or them to tangible facts, previously known or unknown, as anchors to hold the floating synthesis within reach. Much so-called "information" is pure exposition; and not seldom the contempt poured upon it is a reflex of envy of the results secured by the expositor skilled in his function.

The conception of a college course which I have sketched, in its essentials, demands the skilled expositor above everything else. For it proposes to stir the interest of all students and there is only one possible way to do that. Great names in the world of scholars mean nothing to the average college man; they never come to college to study under a great scholar, so far as my experience goes. In my day, at Yale, nobody had any idea that Gibbs was a great figure; and all we knew of Whitney was that he made the German grammar and dictionary, and so must be a very learned man. Seymour too must be a great scholar, we thought, for did he not write that First Three Books of the Iliad! Text-book writers do more to advertise a college among school-boys than any other class of professors. What does the average undergraduate know of the research doings of a professor, or what does he care?

But above all is the exposition. "When you go to college," says an older brother to a younger, "take X's course in Y-ology. Don't miss it. It's an eye-opener. He's hard, but he's got it." "What has X written?" queries the casually listening father, "Has he a national reputation?" "Oh, I don't know about that," is the answer. "I suppose he has. We read a book of his—I've forgotten the title. But he certainly can get it across." And the father knows that is so, for the solicitous eye of the parent, dissembled though his scrutiny may be, has discerned the unmistakable signs of something that has somehow been "got across."

This is no place to go into the qualities of the teacher except to say that he regularly has the knowledge of student-nature—he knows his materials—and the eye for essentials. He does not hope to get in much more than these, and he enfilades and cross-fires with them relentlessly. Such have been all the great expositors and mind-openers whom I have known. And, since a required system naturally evokes some opposition, it would be

particularly necessary for a college adopting that system to emphasize these qualities in appointments.

Another essential for the adoption of any such system would be the courage, not only to introduce it, but to carry it through. One of the means now advocated for improving the college degree consists in abandoning the majority of each class to its fate, letting them slide through as they will, on the analogy, or in imitation of the English "pass-men," and concentrating all attention upon the few "honors-men." The proposal of such a plan seems to some of us un-American, or, if a chauvinistic connotation clings to that term, chimerical. It is a plan that would be maladaptable to American conditions. But, apart from this, it is no way to lift the body of students to a more scholarly level; and I maintain that the American college is bound, even by the very purpose of its endowment, to aim at the body of students. Funds were not given to enable a group of lofty souls to do what they like to do in life; they were meant for the students, and, through them, for the nation. The college is the thing endowed, not the faculty.

The plan developed above would demand courage—the courage to impose a discipline over all which would issue in a considerable mortality among some—those who could not or would not fall in with requirements. Many men would have to take five years to complete the course, and many would be dropped. The plan, as distinguished from the "pass-and-honors" one, would be, not to cause the plant to grow by attaching elastics to the topmost shoots, but by going in with a pruning-hook nearer the roots.

I may conclude by enumerating briefly several of the subsidiary advantages of a course such as I have suggested. First of all, it would help to settle the vexed question of entrance-requirements. The issue would be left bare and stark: what does the college demand in order to have a man prepared to go on for its style of B.A.? If he can present qualifications, well and good; if not, there are other colleges. Next, the congested time-table, with its courses bunched in the forenoons from Monday to Friday, could be spread out into Saturday and the afternoons. No longer could an instructor's course be crippled, as it now is, by placing it on Saturday morning. And for the student there would be no more cases of four exercises or more, nor yet three or four two-hour examinations, on one day. The stress against exodus over the week-end would be strengthened, as also would that against participation in too many extra-curriculum activities—against which even the students protest.

There would not be time, if getting the degree were not to take over four years.

Departments could and must concentrate and strengthen their offerings of courses; the outlying ones must perforce decrease. This would save a great deal of trouble and money for the college.

The expense and irritation connected with making up student schedules would be lessened, and there would be no more lop-sided lists of choices, whereby a student may "specialize" unwisely or overwisely. Irregularities of attendance could be more readily dealt with, and the teachers of all departments better organized to cooperate and march together. At least they could know what their students had already had, and thus be enabled to avoid repetition and to have some idea of what there was to build on. The work of instructors could be tested up; in fact, they would be subjected to a sort of natural selection, and fewer plausible excuses could be found for failures.

The reader who is familiar with the group of irregularities known as the "abuses of the elective system" will see that they could not persist under a "new" required system. There were abuses of the "old" required system, too, but they were less than those that followed upon the lodging, in student choice, of power for determining college policy. A great many of the ills under the old required course were, I repeat, due to the course more than to the element of requirement. There will doubtless be new evils and maladjustments, but these could be dealt with, provided the general policy rested upon the facts, and on the principles derivable from knowledge of them.

And the college that offered a B.A. course of this order would stand some chance of escaping the impending fate of a college in a university: of becoming a mere feeder for the professional schools.

EVIDENCES OF FULL MATURITY AND EARLY DECLINE[1]

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AT the apex of maturity we become aware of an increasing contentment, a welcome feeling that, no matter what happens, we are better able to meet events with precision and judgment. During youth and early adulthood often there obtrudes an undertone of anxiety lest we have omitted or forgotten to do some tasks we ought to have done and didn't. During maturity arises an easement, the natural fruition of fully developed powers, the sum total of training and adaptative measures. We have met and overcome such a multitude of troubles, the onset of another one no longer makes afraid.

Sleep becomes now more tranquil and refreshing, though perhaps not so long nor so deep; action is more deliberate, there is less sense of hurry, of urgency to duties or obligations or indeed to gratifications of sense. Digestion improves in proportion as more time is spent at the table and less is stolen from post-prandial amenities. As a keen young man or a bustling young woman, eager for amusement, there were restless surgings to and fro from sheer prodigality of impulse. The act of feeding thus came to be regarded as merely a negligible incident and hence nutrition suffered. The maturer, more deliberate person tends to become rubicund, to take on weight or at least not to squander it. Accumulation of flesh at this time is natural enough within certain limits of safety. Beyond those bounds, those normal variants, obesity gives evidence of disease, that anabolism is out-running katabolism. Perils begin from this point which may lead to any one of a multitude of destructive happenings.

Mental processes of maturity differ from those of ardent young adulthood chiefly in a relative sedateness as contrasted with adolescent eagerness and exuberance. A calm assuredness now obtains, based on experience, poise; a welcome subsidence comes of early vehemence or overenthusiasm. Initia-

[1] Dealing chiefly with mental (psychophysical) phenomena. A previous paper on the subject will be found in the issue of THE SCIENTIFIC MONTHLY for November, 1917.

tive is still abundant enough, so is confidence and ardor, tempered, however, by an amplitude of contrasts, experiences and discriminative or selective proficiencies. Instead of an idealized enlightenment there comes a product of associations, a familiarity with cognate facts and circumstances leading to justifiable inferences.

Precision in assembling materials for conclusions and in their orderly arrangement constitutes a full equivalent of former lavishness in gathering data. Youthful percepts are almost limitless in plenitude and variety. The imagery of adolescent prepotencies becomes merged in maturity into a clearer and soberer vision of things as they are.

The man of many successes, as the meridian passes, readily comes to overvalue his own opinions; he tends to form conclusions more in accord with personal limitations, his prejudices, with the point of view of his habitual angle of approach, rather than that warranted by the facts. He may be, and usually is, less ready to change and modify than would a younger one upon presentation of adequate evidence.

In the psycho-physical sphere that which can now be most safely counted on is the measure and degree of fruition attainable through favorable environment, through liberalized variety, through healthful and stimulating mental and moral influences. The mind exerts paramount effects on both development and on survival values, hence the significance of having attained right points of view and disposition during the plastic years. Thus a serene temperament is achieved.

When the body degenerates and declines there is nothing left but the husk from which the spirit fades till it disappears. Whatever view one may hold as to the ultimate fate of the vital spark, it is obviously something with points of similarity to the springs of action in survival energies. We picture our future in accord with the best teachings; the more beautiful and reasonable manifestations of dynamics, the better.

To do justice to the subject of mental characteristics which distinguish maturity would involve a survey of general psychology beyond that which is permissible here. All that can now be offered are a few memoranda of those mental peculiarities displayed in maturity which shadow forth the beginnings of senescence.

In certain individuals the mind remains soundly integrated till the end of a long life, so clear, the memory so retentive, the perception and judgment so keen, that they enjoy the appreciation of their fellows till well into the eighth or ninth decades.

Through such exemplars we learn that senile mental decrepitude is not inevitable under fairly favorable conditions: only a normal decadence, *i. e.*, a series of normal phenomena of devolution varying in kind, but little or none in degree. Abnormal physical changes accompanying old age, on the contrary, may be of the widest latitude. Indeed, energies and integrities of the mind may, and often do, far outlive those of the body.

It should be remembered that some mental phases of overripeness are merely the result of lax methods of thinking, of inattention, of defects or neglects of memory, of faulty habits, and not due to morbid alterations in structure. If, or when, unlovely mental peculiarities persist, become pronounced features, they may indicate gradual retrograde cell changes. These may not increase for many years.

Such of the changes as do occur in the mind and temperament as a part of early senescence are often enough mere exaggerations of long-existing inherent peculiarities, those which have grown up in one by reason of the preponderance of original trends or have not been held under adequate subjection.

The physical changes in senescence are gross and obvious, of little importance, especially in the higher walks of life where physical decrepitude is of a far less seriousness than mental. The state most worth striving for is to keep both mental and physical fitness on a par; to gain this end they must be constantly and freely used.

Mental and moral impairments are, fortunately, not inevitable till the last call is sounded. Indeed it is a blessing that defections in the mental and moral domain are not inevitable. After all, it is the manhood, the personality, which tells, rather than those threatened inroads of structural decadence which we desire and strive to escape.

Of the mental changes characteristic of later maturity, some are of towering significance and others matters of indifference. Variations during the high tide of maturity are wide in accordance with the life one has led, and especially the sort of mental occupation followed. Mental changes, being of widest scope as contrasted with the limited sphere of physical alterations, can only be mentioned in so brief a review of the subject.

The distinguishing characteristics of the mature mind are poise, deliberation, economy of effort with largest output of judgment. To be sure, it is to the old man that the laurel crown of wisdom was given in Rome—senes—senator—the highest body of legislators.

The earliest retrograde mental changes are due chiefly to

wandering of the attention, loss of capacity to fix and hold it, to concentrate. The exceptions are when individual comfort is concerned.

As old age progresses these mental features are those of decline in capacity, in grasp, in coordination. Some, indeed a large part of senescent mental abnormality, is due to fatigue reactions from over-strained attention. This is far more likely to be the product of exhaustion from monotony, wearisome routine than from effort. Impairment of mental efficiency leads to dissatisfaction, distress; and the worst effects are from protracted anxieties, from exhaustion which follows diffusion of thought, therefore of clear percepts, and hence "poverty of memory pictures, the one precious possession of the aged."

Attention being unrelieved, it wanders or spreads over one group of objects and loses sight of others. Unrest follows and a habit of onesidedness in the outlook on life. Absorption in one line of mental pursuit, such as of science or art, becomes so fascinating, so confining, that a man may become indefinitely happy in one narrow line of pursuit, therefore he grows indifferent to surroundings.

This narrowing of the personality, this shut-in-ness should not be allowed to become a mere selfish indulgence and disregard of others' opinions and feelings; it may lead to petty tastes, to trivialities, to whims, to vanity into which all of us are tempted to fall.

What, indeed, is growing old? Old age is one thing (senility), and the process of growing old (senescence) is another. Old age implies length of days, accumulations of years, the inexorable process of chronologic advance. Growing old structurally is a variable state: Some do so more slowly and others more rapidly, in accord with varying conditions of inheritance and also in manner of life, favorable or unfavorable.

Variants occur due to causes inherent or acquired; also differ in different individuals, in families and in races. Old age implies mere progress of time; senility indicates deteriorations (abnormalities) in structure and hence also in function.

Senility is due to deterioration in somatic (body) structures and is, for the most part, caused by excessive accumulations of self-formed poisons (above what the eliminating machinery can get rid of) and to a few poisons from without, *e. g.*, alcohol, tobacco, tea, coffee, lead, mercury and other foreign or valueless substances to which mankind is exposed.

Senile changes, limiting functional integrity, may be grouped under the general caption of impairments in elasticity, in plas-

ticity; the old cells become too stable, too rigid, too static. Hence the maintenance of elasticity, so far as this is possible, makes for efficiency in structures and the postponement of devitalization.

The problem before each one of us is how to attain old age while continuing to be able to render the best service with the least cost in effort, in adverse conditions, and in distress. Hence the factors are not only physical, but also economic and social or sociologic.

The aged are notoriously conservative, accepting novel ideas or suggestions with reluctance or flat denial. Parsimoniousness alternates with misanthropy. Self-restraint, in short, is waning, and may be shown in both ludicrous and pathetic directions. Temptations aforetime readily resisted now overcome former conscious control.

When the reproductive powers have ceased, capacities for affection subside. All actions or thoughts correlated with sex impulses become changed. Yet old men occasionally commit absurd or dangerous follies through sex instinct, becoming suddenly impulsive, imperative, despotic.

The best average barometer of mental failure is memory in all its varieties—only an advance guard of an invading army that is sooner or later to devastate the brain. (Clouston.)

Attention can then no longer be sustained, is readily fatigued; mental and physical energies are diminishing. Imagination no longer colors and illumines thought. Enthusiasms fade away, as does adaptability to change and ideation.

The old have no faith in the young. (H. M. Friedmann.)

Old persons display a tendency to overeat, in spite of the maxim that "one should descend out of life as he ascended into it, even unto a child's diet." Feeding is the one remaining pleasure, and among old people in special "homes" or asylums are found wonderful trenchermen who survive amazingly so long as they live in that atmosphere of undisturbed tranquillity.

The craving for rest and quietude in the aged is of organic origin. It permits of a systematic and orderly arrangement and storing of facts and makes for excellent mental products in those whose energies are well sustained. Particularly valuable are the thoughts, opinions and conclusions of old age when earlier training was along well-defined lines of science or philosophy or art. The greater mental detachment accentuates judicial poise; enthusiasms are then in abeyance or gone, hence conclusions are more in accord with underlying truths.

Intellectuality is shown at the best in many aged persons. Mental force depends on the kind of constitution possessed plus the nature and quality of early training. Indeed, no greater pleasures can be enjoyed in the twilight of life than a sustained interest in one's early absorbing occupations. Of course only certain aspects of these can be carried to legitimate fruition. It is always possible for some one or other department, direction or phase of knowledge or activities to be continued or elaborated.

Age being a purely relative term in all but the chronologic or legal sense, there can be no period fixed for its characteristic phenomena to begin. Modifying conditions are such as reside in individual makeup, environment, points of view, training, habits, tastes, prejudices, physical fitness and qualities of energizing.

> The redeeming features of old age are that one is (then) freed from the demands of former youthful passions, emotions and sentiments—if, indeed, such freedom is worth while. The old have, besides the relative advantage of immunity to certain diseases, such as the eruptive fevers, typhoid and phthisis; the old tissues do not seem to be good media for these disease agencies. On the other hand, they are very prone to pneumonic infections and erysipelas, which carry away most aged folk. (H. M. Friedmann, *op. cit.*)

The phenomena of aging—growing old—are normal, but so frequently are they obscured by abnormalities that the impression obtains that old age is a disease. Professor Ribot (editorial *N. Y. Med. Jour.*, Sept. 26, 1908) points out the contrasts admirably thus:

> In pathologic death in late age, the general cells cease to retain their powers of rejuvenation by means of external influences (bacteria, toxins, etc.) and the part ceases to perform its function. Physiologic death is, in the main, the result of failure of the brain and central nervous system to function.
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> Natural death in senility is therefore a consequence of anatomical, together with functional changes in the component factors of the body, partly of the cells and partly of the intermediate substances. These changes in death are not the result of external influences (such as, *e. g.*, of too much or of improper food, of disease-producing influences, toxins, etc.), but they are necessary sequels to the chemical expiration of the phenomena of life.
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> In the cells are formed clinkers so to speak, deposits which are products of metabolism, bringing about atrophy of the bioplasm. The intermediate substances, which are not living matter in the real sense of the word, commence to relax generally in their more or less mechanical functions, thus damaging the circulatory apparatus. This process is of detriment to the cells, the atrophy of which is thereby increased.
>
> Diseases of senility, especially arterial degenerations, favor the ac-

complishment of old-age changes and conditions, but they are not integral parts of old-age conditions; they are merely complications. Old age is *per se* normal; is free from diseased conditions. Especially responsible for natural death in old age are the ganglion cells, which have always the same elements. Hence physiologic death in the aged is thus more or less of a brain death.

RÉSUMÉ OF MENTAL PHENOMENA OF BEGINNING OLD AGE, NORMAL SENESCENCE

The mental phenomena of senescence are exaggerations of those of over-maturity.

We may take comfort, however, in the well-demonstrated fact that in one of vigorous constitution the brain and its functions are also pretty certain to be and remain sound till the final fading away of forces.

The mind and all the finer faculties grow dulled in the elderly. Permitted to live in an atmosphere of comfort and peaceful routine, they are serene enough and may continue so indefinitely. Interruptions, invasions of their tranquillity are resented. Contradictions or other oppositions shock their equipoise, jolt an equanimity now readily disturbed; they thereupon display peevishness, irritability of temper, irascibility or petulance. Likewise a tendency to commit diverse follies of impulse is noticeable, to exhibit puerile ambitions and vanities, boastfulness, assertiveness, jealousies, misanthropy, coldness of disposition, indifference to family and communal ties, duties and responsibilities.

A much greater stimulus is needed to arouse sense perception in the old; responses to sensory impacts are slower, more inadequate.

The tissues involved are losing their impressions, also their capacity for impressionability. Reflex action becomes more sluggish and weaker. Instinctive acts grow fewer.

Irritability is diminished, is noticeable in all acts; the power of originating action independent of stimulation (or irritation) becomes weaker in the aged, whereas it is prompt in the young.

The regulating centers are weakened, irresponsive, though oftentimes over-sensitive to disturbances.

The acts of the aged result more from conscious purpose, from careful reason, and from habit, or they follow only upon strong irritation.

Instinct has subsided, is replaced by experience and prejudice.

Inadequate repair follows injury in the condition of growing old, especially in the more highly differentiated structures,

—the more sensitive ones, notably whose functions require for right action large supplies of blood, such as the ductless glands, the spleen, the adrenals, the brain, nerves, marrow and muscles.

Memory becomes impaired because mental perceptions have become weakened, therefore only powerful stimuli make impressions; those most affecting the individual are retained and reproduced. Hence a strong effort must be then made to recall recent events or circumstances, whereas the earlier ones are readily reproduced.

The child demands to know "why," opens up objects, pulls apart, observes the component cells and structures. The senile mind is better fitted to construct, or especially to reconstruct.

The aged mind becomes narrowed in its outlook to those subjects which concern self and especially on matters bearing on self-preservation.

Youth wants to know; age wants to be. (Nascher.)

In crowding years one is haunted by a fear of death in spite of all the offered consolations of religion and philosophy. The emotions of those passing down into the valley lose their equipoise in proportion as reasoning powers fail and mental balance lessens.

The onset of climacteric limitations in both sexes is marked by mental changes in the point of view. The temperament veers; the angle from which one views life, as the shadows grow long, is altered. Men are more hopeful for the time and after the "change of life sink into relative apathy or gloom."

In women their innate vanity supports them in great measure to keep up appearances; also their religious feelings, their optimism and their faith in the power of things unseen, supports them to maintain a cheerful front and a good appearance.

Among the mental manifestations of senility are:

Impairment of memory; of capacity to perceive, to observe; and to fix attention on current happenings. The mind wanders, veers about, drifts.

Interest in surroundings diminishes except as the individual comfort is concerned.

Doubts are readily entertained; new ideas are challenged. Conscience becomes blunted increasingly as old age advances.

Automatic acts replace the more volitional ones, *i. e.*, habit paths in motor and psychomotor mechanisms become relied on to the exclusion of the failing initiative. This increases as time progresses.

At first, in early childhood, all motor acts are the products

of initiative, of will; then these acts become automatic, habitual, merge into instincts, and, as they fade, mere automatisms remain.

As age advances the phenomena of animal life gradually subside, actions become fewer and fewer and less and less controlled by will. Man retires more and more into himself, or the shell of his self; becomes isolated, is shut out bit by bit, from his surroundings and becomes absorbed in his own personal doings or survival.

In these insignia are shown the tendencies of the man, how he is influenced and narrowed by social and domestic considerations rather than the cultural effects of age, in short how "an individual reacts to the deterrent effects of aging processes and submits to become a marionette, responsive to fewer strings."

If only lower ideals are exerted, a man or woman drifts along the path of least resistance.

All this breeds increasing littleness, selfishness, which may become most disfiguring, unlovely.

The way to remain essentially young and also retain the appearance of youth is to "cultivate variability," (Boris Sidis) widen the point of view, to expand the interests. It is desirable to resist as long as possible the lowering of the curtain, "playing the rôle of the solitary unit."

Vastly more important than to pursue over-eager measures contributing to lengthening days is to keep in touch with affairs, maintain warm relationships with environment, domestic, social and especially national.

Old age has natural affinities for childhood and youth. A young life as a companion is the best tonic. To make oneself loveable is the most important aim. Cheerfulness is the key—to keep trying to reach out and affect other personalities. Old age laments becoming useless; yet one can never tell how far one's influence extends.

Growing old ungracefully is thus described by Elliot Gregory:

> There comes, we are told, a crucial moment, "a tide" in all lives, that, taken at the flood, leads on to fortune. An assertion, by the bye, which is open to doubt. What does come to every one is an hour fraught with warning, which, if unheeded, leads on to folly. This fateful date coincides for the most of us with the discovery that we are turning gray, or that the "crow's feet" on our temples are becoming visible realities. The unpleasant question then presents itself: Are we to slip meekly into middle age, or are arms to be taken up against our insidious enemy, and the rest of life become a losing battle, fought inch by inch?

In other days it was the men who struggled the hardest against their fate. Up to this century, the male had always been the ornamental member of the family. Cæsar, we read, coveted a laurel crown principally because it would help to conceal his baldness. The wigs of the Grand Monarque are historical. It is characteristic of the time that the latter's attempts at rejuvenation should have been taken as a matter of course, while a few years later poor Madame de Pompadour's artifices to retain her fleeting youth were laughed at and decried.

The situation to-day is reversed. The battle, given up by the men—who now accept their fate with equanimity—is being waged by their better halves with a vigor heretofore unknown. So general has this mania to retain youthfulness become that if asked what one weakness was most characteristic of modern women, what peculiarity marked them as different from their sisters in other centuries, I should unhesitatingly answer, "The desire to look younger than their years."

. . . The men or women who do not look their age are rare. In each generation there are exceptions, people who, from one cause or another—generally an excellent constitution—succeed in producing the illusion of youth for a few years after youth itself has flown.

The desire to remain attractive as long as possible is not only a reasonable but a commendable ambition. Unfortunately the stupid means most of our matrons adopt to accomplish this end produce exactly the opposite result.

One sign of deficient taste in our day is this failure to perceive that every age has a charm of its own which can be enhanced by appropriate surroundings, but is lost when placed in an incongruous setting. It saddens a lover of the beautiful to see matrons going so far astray in their desire to please as to pose for young women when they no longer can look the part.

Holmes, in "My Maiden Aunt," asks plaintively:

Why will she train that wintry curl in such a springlike way?

Few matrons stop to think for themselves, or they would realize that by appearing in the same attire as their daughters they challenge a comparison which can only be to their disadvantage, and should be if possible avoided.

There are still, it is to be hoped, many such lovable women in our land, but at times I look about me with dismay, and wonder who is to take their places when they are gone. Are there to be no more "old ladies"?

I am grateful to Dr. H. M. Friedmann, Dr. Robert Saunby, Prof. Charles Sedgwick Minot and Dr. I. L. Nascher, whose contributions to the subject of advancing age and its treatment are filled with valuable points.

CHEMISTRY IN MEDICINE IN THE FIFTEENTH CENTURY

By PROFESSOR JOHN MAXSON STILLMAN

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THERE lies before the writer a stately folio, printed in Strassburg in Alsace in the year fifteen hundred, not written in the conventional Latin of the scholars of the period, but in the German language. It is a work not unknown to historians of pharmacology and medicine, but the significance of the movement it represents and the influence of its publication upon the development of chemistry and of materia medica seem not to have received the appreciation it deserves. The title of the work, translated, reads: "The Book of the Art of Distilling Simples, by Hieronymous Brunschwygk, a native and surgeon (Wundartzot) of the imperial free City of Strassburg."

The book is noted as one of the earliest printed books giving circumstantial descriptions, with many illustrative wood-cuts, of the apparatus and methods of distillation in vogue with the chemists of the fifteenth century. It is also noted among the early herbals on account of its many descriptions of medicinal herbs with illustrative wood-cuts.

The first division of the book is devoted to descriptions of the construction of furnaces and of the various forms of stills, retorts, receivers, condensers, etc., and of the various methods of distilling: by direct fire, from water bath, by the sun's heat, by the use of the gentle heat of fermenting horse-manure, etc. It is interesting to note that as with still earlier authors on distillation, there is included under this head the distillation "*per filtrum*," which consisted in siphoning, by means of a felt cloth, the liquid from one vessel to another placed at a lower level. This process is then not really distillation, but is what we now call "*filtration*."

Especial emphasis is laid upon the distillation and preservation of "waters" distilled by these various methods from medicinal herbs or from other substances which the pharmacology of the time recognized as of remedial value.

The second division of the work is devoted to the description of many plants and other medicinal agents, alphabetically ar-

ranged, with wood-cuts illustrating them, directions as to the parts to be subjected to distillation, the time or season for their preparation, and the complaints which the distilled waters are supposed to benefit with the doses for their application.

A single example will best serve to illustrate the character of these descriptions.

Mulberry water, by the Greeks called *Mora*, by the Arabians, *hoc*, and by the Latins, *Moracelsi*, and by the Germans, *Mulber*, is a tree well known to many. The best part, and the season, is the fruit or berry when perfectly ripe, but not near its falling.

A. Mulberry water, drunk three or four times a day, two or three ounces each time, and also well gargled, dispels the complaint of the throat called quinsy.

B. Mulberry water when drunk every morning, noon and night, for five or six days about four ounces each time, dispels ailments of the chest and stomach and softens and expels excreta.

C. Mulberry water drunk as above directed is good if one has fallen and has coagulated blood, which it scatters and dispels.

D. Mulberry water drunk as above directed is also good for a cough and expands the chest.

E. Mulberry water reduces the veins when rubbed with it and pressed with it (varicose veins?).

F. Mulberry water, when not quite ripe or when ripe is good for the eyes when introduced into them or when they are bathed with it.

G. Mulberry water from unripe mulberries is a principal water for the palate and epiglottis, especially if one gargles well with it three or four times a day, about three ounces each time, for it takes away all rawness and heat from the throat, as I have often observed.

The list of waters similarly described which makes up the greater part of the bulky volume includes distillates from many common plants and herbs, but is by no means confined to these —for the list includes waters distilled from many other substances then accepted by medical authorities as possessing curative powers:—oxen-blood, ants, frogs, frogs' eggs, flies, and many other substances the like of which are now only to be found in the traditional pharmacopeia of China.

The book concludes with a formality characteristic of the period:

> Herewith is completed the book called the book of the art of distilling

simples, by Jeronimus Brunschwyg* surgeon of the imperial free city of Strassburg, and printed by the highly respected Johann Grüninger at Strassburg on the eighth day of May, as one counts from the birth of Christ fifteen hundred. Praise be to God.

The distilled waters of Brunschwygk have left but little trace in the pharmacology of to-day, yet, foreign to modern practise as these remedies are, it is manifest that his work or the practise which it represented exerted a very considerable influence on the popular medicine of the time. The work of which the above is the first edition passed through at least nine editions. It was followed (1512) by another work by the same author on the distillation of composita, extending the system beyond the single substances or simples to more or less complex mixtures, and this work also passed through several editions. Imitations, translations and works by later writers extended the literature of distilled medicines to a very considerable volume, evidencing a very prominent popular vogue of these distillates or filtrates instead of the system of powders, syrups and decoctions which the traditional ancient and university authorities recognized.

So far as the writer has been able to ascertain, the book of Brunschwygk is the first book which presents a system of remedies based upon distilled (or in some cases filtered) waters from the numerous and varied substances familiar to the medical practise of the time.

In this respect it marks a distinct departure from the scholastic medicine of the middle ages, and was without doubt an important agent in the influences operative in breaking down the walls of scholastic conservatism in medicine, and in initiating the revolutionary movement which culminated a century or more later in opening the way to the union of chemistry and medicine.

The author of the Book of Distillation makes no claim to originality in introducing this system of medicines, nor is it probable that his book is other than a formulation of practises in use in a certain group of medical practitioners and especially of a notable group or guild of Strassburg surgeons which attained a very considerable prestige and of which Brunschwygk was the most noted in his time.

The Book of Distillation of Simples, in its general plan of arrangement, except for the part on distillation methods and apparatus, was modeled on the earlier Herbals. These were illustrated descriptions of plants, intended for the more accu-

* Our author is not particular about the spelling of his name. It is spelled in three different ways in this book.

rate identification of medicinal material, and also included synopses of the virtues of the plants and their application in medicine. The distinct departure of this book from its predecessors lay in the idea of applying the processes of chemistry to the separation of the supposed active principles from these raw materials. The traditional method of utilizing the remedial substances—the method sanctioned by the authority of the Greek and Arabian authors whose teachings were the accepted dogmas of the learned doctors of medicine—was as powders, decoctions, syrups or plasters. The idea of separating a purified principle by distillation or in some cases by solution and filtration was from the point of view of the medical faculties heretical and a phase of ignorant charlatanism.

The theoretic basis of this new medical practise is doubtless to be found in the neo-platonic theories of nature, which under the leadership of the Florentine Academy exerted a strong influence at this period and was at variance with the traditional Aristotelianism of the schools. One phase of this philosophy recognized in all things animate and inanimate a soul or spirit which represented the essential principle as separate from the grosser materials of its body. The then familiar knowledge of the obtaining of alcohol—the "spirits of wine"—and the method of distilling essential oils and perfumed waters, already developed to some extent by the Arabian chemists, served to give a substantial experimental illustration of the theory. By these processes from the gross and perishable raw substances a purified "spirit" or "essence" was obtained. It was in all probability the extension of these ideas to the domain of medicines which gave rise to the practises of the Strassburg surgeons and their fellows or followers.

However analogical and unscientific may have been the reasoning upon which the "distilled waters" school of practitioners, and however little permanent place the medicines of Brunschwygk's pharmacology have found in modern medicine, it is not to be denied that there was contained in their method the assumption of a fact of importance, that it is possible to extract by chemical methods from many substances a pure principle more efficacious than the crude material from which it is obtained. And it is also true that the historical importance of the movement inaugurated or first formulated by Brunschwygk is not to be measured either by the correctness of its theoretical foundation or by its permanent contributions to medical practise, but by its influence upon its own epoch and the relation of that influence to the future development of

the science. The nature of this influence then is the important consideration here.

Students of the history of chemistry and of medicine recognize the sixteenth century as the rise of the period of "Iatrochemistry" or the application of chemistry and chemical points of view to medicine and pharmacology. Modern historians of medicine generally credit the inauguration of this revolutionary movement to the influence of Paracelsus and his disciples and followers, Crollius, Van Helmont, Thölde (Basilius Valentinus), Glauber and others; and justly so, for the life-long battle of Paracelsus against the medieval slavery to traditional authorities, for open minds to new experiments and observation, and for the recognition of chemistry as a pillar of medical science, was determinative of a new impetus to chemical science and of a breach in the medical profession which eventually won for chemistry its recognition as an essential factor in medical theory and practise.

Without in any way disparaging or minimizing this influence of Paracelsus, it nevertheless seems fairly certain that the influence of the school of chemical physicians represented by Brunschwygk was important in supplying Paracelsus with no inconsiderable part of the basis and the inspiration for his campaign.

Brunschwygk was born at Strassburg about 1450 and died there about 1534. Paracelsus, born 1493, had studied chemistry in the laboratories of the mines of southern Germany and Austria. In 1526 it is recorded that Paracelsus was himself granted citizenship (Burgrecht) in Strassburg and assigned to the guild of "Lucerne" to which the surgeons (Wundärtzte) also belonged. It was in the same year that he began his war against the conventional medicine of the faculties at the University of Basel. It is to be remembered that the Book of Distilling Simples first printed in 1500 had passed through several editions before Paracelsus was assigned to the guild of surgeons. Though Paracelsus makes no reference in his works to Brunschwygk or his book, there are many passages in his works which show him to be more or less familiar with the practises and theory which underlie the work of Brunschwygk.

For instance, speaking of Simples, he says:

> The virtue in a simple is one and not divided into three, four, five, etc., and a simple needs only chemistry ("Alchemia"), which is nothing different than with the miner or metallurgist, it consists in extracting, not in compounding, it consists in recognizing what is contained in it, not in mixtures and patchwork.

So again referring to chemistry (Alchemia) he says:

If in this (art) the physician is not in the highest degree skilled and experienced his art is all in vain. For nature is so subtle and keen in her affairs, that she cannot be used without great skill. For she yields nothing to us that is perfected in its place (occurrence) but man must perfect it. This perfection is called alchemy.

To such as the author of the distillation book the following passage from Paracelsus, "De Natura Rerum," seems very definitely to refer:

The separation of those things that grow from the earth and are easily combustible, as all fruits, herbs, flowers, leaves, grass, roots, wood, etc., takes place in many ways. Thus by distillation is separated from them, first, the phelgm,[1] then the mercury[2] and the oily parts, third, its resin, fourth, its sulphur,[3] and fifth, its salt.[4] When this separation has taken place by chemical art, there are found many splendid and powerful remedies for internal and external use.

But because the laziness of the reputed physicians has so obtained the upper hand and their art serves only for display, I am not surprised that such preparations are quite ignored and that charcoal remains cheap. As to this I will say that if the smith could work his metals without the use of fire, as these so-called physicians prepare their medicines without fire, there would be danger indeed that the charcoal burners would all be ruined and compelled to flee.

But I praise the spagyric (*i. e.*, chemical) physicians for they do not consort with loafers, or go about gorgeous with satins, silks, and velvets,—gold rings on their fingers, silver daggers hanging at their sides and white gloves on their hands, but they tend their work at the fire patiently day and night. They do not go promenading, but seek their recreation in the laboratory, wear plain leathern dress, and aprons of hide upon which to wipe their hands, thrust their fingers amongst the coals, into dirt and rubbish and not into golden rings. They are sooty and dirty like the smiths and charcoal burners, and hence make little show, make not many words and gossip with their patients, do not highly praise their own medicines, for they well know that the work should praise the master, not the master his work. They well know that words and chatter do not help the sick nor cure them. Therefore, they let such things alone and busy themselves with working at their fires and learning the steps of alchemy (chemistry).

From these and other expressions it seems fairly to be inferred that Paracelsus was cognizant of and sympathetic with the ideas and practise of the distillers of simples.

It is true that the application of chemistry to medicine as visualized by Paracelsus transcended in extent the distilled waters from the conventional remedies of Brunschwygk, and his own practise extended to the use of inorganic salts and com-

[1] Meaning the watery distillate.
[2] With Paracelsus this includes volatile or gaseous products.
[3] That which burns.
[4] The ash or fixed residue.

pounds of metals which would perhaps have been as abhorrent to the chemical physicians of the Strassburg school as they were to the medical faculties themselves. But it may well be true that a large part of the impetus to his campaign was derived from the Strassburg surgeons, and that his own experiences in the chemistry of the mines and the homely remedies of the mining regions supplemented and extended his ideas as to the utilization of chemistry in medicine.

That Paracelsus had knowledge of the Herbals and had a certain contempt for the various claims for the virtues of the remedies therein described is evident from a passage which applies equally well perhaps to the Brunschwygk pharmacology as to its predecessors:

> Open one of these Herbals and you will there find how one herb has fifty or a hundred virtues, and open their books of recipes and you will find forty or fifty such herbs in one recipe against one disease.

A better understanding of the significance of the origin of this school of medicine in the guild of surgeons may be obtained if we recall the relation of these to the medical profession in the period which we are considering.

Even under the Roman Empire the occupations of physician and surgeon were separate, as was also the business of collecting, preparing and selling of drugs and medicines.

In the early Renaissance, and throughout the period of the distillation books, the doctors of medicine were very conventionally and generally very superficially trained by lectures or readings in the dogmatic theory and practise of traditional authorities. Their knowledge of physiology and of anatomy was in general slight. Independent observation and experiment were practically inhibited by their oaths of allegiance to traditional authority and by professional caste pride. Custom also dictated that the physician was not to lay hands upon his patient in the way of any operations. In case bleeding or leeching was considered necessary, the barber was called in, in more grave operations—fractures, amputations or internal operations—the surgeon was called upon. It developed that, generally speaking, the doctors of medicine became more and more rigid in their adherence to the dogmatic medical theories, and less and less capable of progressive development.

The surgeons, on the other hand, were in general not men of traditional learning nor necessarily trained in the Latin of the scholarly classes. They learned their art by apprenticeship under older surgeons, and sometimes also in special schools for surgeons. They were not "*doctors*" but "masters" (magis-

ter). Theirs was a skilled trade, not a profession. In the wars it was the surgeon who accompanied the troops to dress their wounds and to care for their health. The surgeons were very often also appointed as city physicians (Stadt-Artzte) to care for the health of the poor who could not well afford the high fees of the regular doctors nor to pay the prices for their often costly prescriptions of rare and far-fetched medicines.

The surgeons, therefore, very naturally developed a medical practise less founded on scholastic traditions than upon their own experience with popular and homely remedies, though naturally also greatly influenced by the traditional practise of the scholarly physicians. Their practise tended more to an empiricism which, however unscientifically founded, yet had the advantage that it was not bound by the traditions of authority which limited the regular school, and was more open to the reception of new and progressive ideas. The surgeons also, by the nature of their experience in the performing and care of serious operations and their care of the poor, acquired a better knowledge of anatomy than the doctors.

It is not surprising, therefore, that as early as the twelfth and thirteenth centuries in Italy, the thirteenth and fourteenth centuries in France, and soon after in Germany, the surgeons became recognized as a strong and influential group, and that even as medical practitioners were often strong competitors of the regular physicians for popular favor. The names of Lanfranchi, Mondeville, de Chauliac, in France in the thirteenth and fourteenth centuries, and of Brunschwygk and Von Gersdorff in Strassburg, are illustrations of surgeons who attained distinguished eminence. Brunschwygk himself was the author of a work on surgery, apparently the first printed treatise by a German surgeon, first printed in 1497 in Strassburg and passing rapidly through many editions.

The surgeons of the period were then also medical practitioners with a very considerable following among the people, however discredited by the learned classes. But because they were not bound by allegiance to recognized authorities whose teachings were held as almost sacred by the university doctors, they were more open to new ideas and better able to profit by the results of their own experience. Thus their influence grew with the advance in knowledge more rapidly than did the influence of the conservative physicians.

Hence it is that the surgeons were the ones who first took cognizance of the development of chemical methods and phenomena and endeavored to apply these methods to the purifica-

tion and preparation of medicines. And as above suggested it is probable that the neoplatonic idea of the existence in every medicinal substance of a pure essence or "spirit" which was the active remedial agent, was the origin of this first attempt to apply chemistry to the practise of medicine. The author of the "Liber Destillandi" himself explains that the distillation of his "waters" is for the purpose of separating the active agents from the impurities which complicate or interfere with their action. To what extent the methods and practices of the Strassburg school represented by Brunschwygk prevailed in other localities at the time is not known to the present writer, but from the fact that the distillation books of Brunschwygk and others enjoyed such an extensive popularity as is evidenced by their many editions and translations, it is evident that their influence was not insignificant. That Paracelsus a quarter of a century after the publication of this first edition of the "Liber Destillandi" evidently was to some extent inspired by this movement in inaugurating his campaign for the union of chemistry and medicine, seems fairly to indicate the important place of this early phase of chemical medicine in the history of the application of chemical experience to medical development.

Brunschwygk's "Liber Destillandi" appears to be the first published systematic attempt to graft upon the practise of medicine the methods and the theories developed by the early chemists. Though that attempt contributed little of permanent value, it very manifestly assisted in inaugurating the movement for the union of chemistry and medicine which by the campaign of Paracelsus and his disciples developed into a revolutionary movement both in chemistry and in medicine, a movement which since has been continuous and of ever-increasing importance.

METEOROLOGY AND THE NATIONAL WELFARE

By ALEXANDER McADIE

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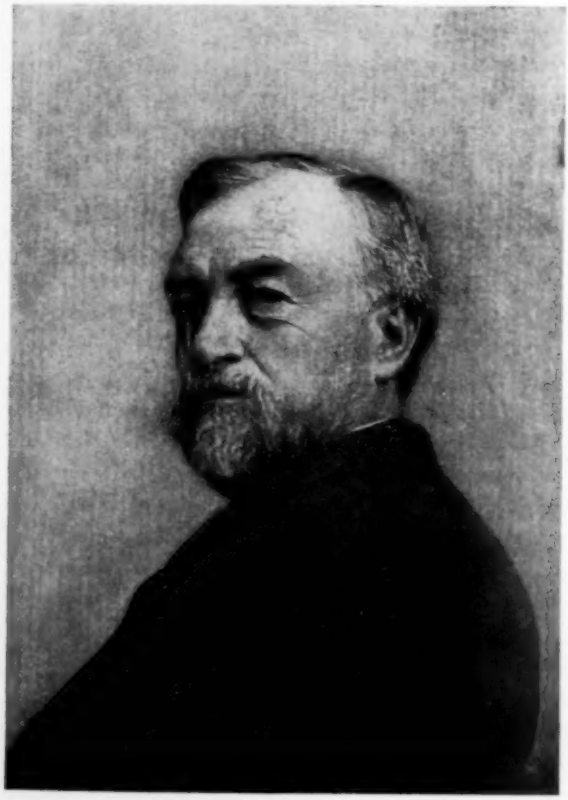
THERE are some who maintain with cheerful optimism that a stirring of the pool is beneficial for nations as well as individuals. For there seem to be results which the untroubled waters never give. In the present world-wide war surely we have had a stirring sufficiently vigorous to satisfy all anticipations, and it only remains to look for the great good which should follow according to the premise. Certainly there have been great economic, social and political consequences. Among others we may cite the limitation in the use of vodka in Russia, the restricted use of liquors and stimulants in general, the suspension of distillation of spirituous beverages in the United States, the regeneration of Russia politically, the spread of democratic ideas, the exploitation of Africa, the development of under-sea craft and submersibles, and standing out most conspicuous of all, in meteorology, the conquest of the air. Without question the great war has given a stimulus to the art of flight and the construction of air-runners which twenty years of peace might not have equalled. There is no doubt now in the mind of the public as to the future use of the air in the transportation of mail and fast freight. And this present mastery of the air, the medium in which we move, is the greatest advance yet made in the long campaign in which men have sought to rise from earth and rival the birds.

Twenty centuries have passed since men began to speculate concerning the nature of air. Practically there was no advance until a Florentine experimenter (he had had the benefit of a few months' acquaintance with Galileo) turned a tube of mercury upside down in a bowl of mercury. That simple experiment demonstrated that a balance could be maintained between the column of mercury *in vacuo* and something outside, that something being the atmosphere. The master himself died without comprehending the law of aerostatic pressure. It seems simple enough now and every schoolboy understands it, but previous to the middle of the seventeenth century no one knew that human beings walk around at the bottom of a sea of

air which presses upon every square centimeter of their bodies with a force equivalent to 34.5 grams, or if we can not free ourselves from the old English units, with a force equivalent to 14.7 pounds per square inch. It required the composite genius of Torricelli the Florentine, Pascal the Parisian, von Guericke the burgomaster of Magdeburg, and Boyle the Dorsetshire squire, to make plain to men this simplest of facts, namely, that the air in which we move and live and have our being is a physical substance which can be weighed and compressed. It was not until the latter part of the eighteenth century that Cavendish, the most solitary figure in science, announced the chemical composition of atmospheric air. But not until the first decade of our own, the twentieth century, did it occur to men to make use of the inertia of the air. And this, Professor Langley and the Wright brothers did.

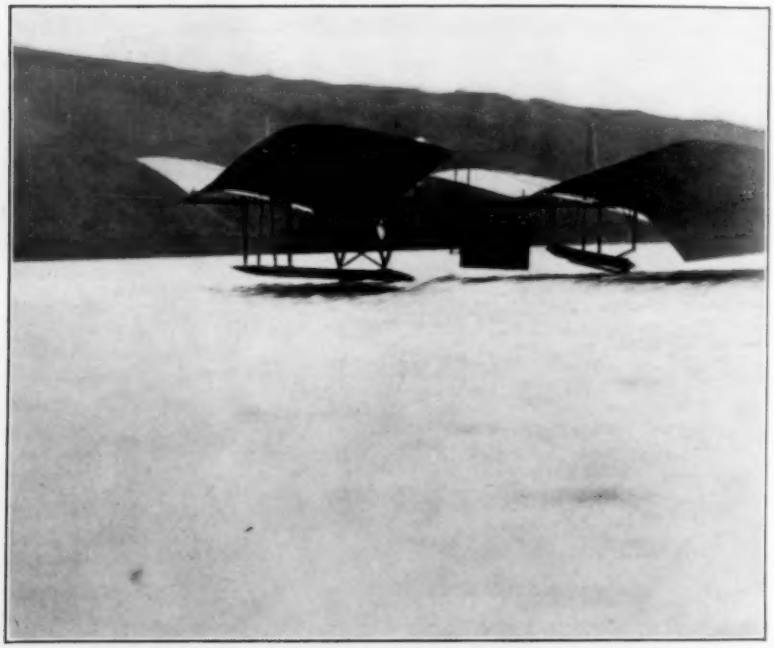
The airplane is simply a skimming plane taking advantage



PROFESSOR S. P. LANGLEY

of the inertia of air at rest. But there is also the inertia of air masses in motion and as yet full advantage of this has not been taken. In the mass motion of air there is a vast store of energy as yet not utilized by man.

Strangely enough, nature did not provide man with any special sense organism whereby changes in air motion could be instantly detected. He only realizes changes due to pressure, when he climbs or is carried to a great height. As for temperature, the average man thinks he is responsive, but in reality always confuses the effects of heat and humidity.



LANGLEY AERODROME IN FLIGHT OVER LAKE KENKA, JUNE 2, 1914

As for changes in the density of the air, or in its ionization, or electrification and nucleation, mankind is as yet hopelessly in the dark. A few laboratory experiments made with apparatus of great sensitiveness mark the boundaries of all that vast unknown. At present we can only wonder and wait. Even in so near a matter as the changes in the internal energy of a mass of water vapor we are sadly handicapped. We are not in any way directly cognizant of the processes of cloudy condensation. Perhaps if we were we could tell in advance weather changes and say with some certainty when the rain would begin and end. We ought to be able to do these things, and yet even official

weather forecasters fall far short of accuracy and, indeed, as the writer has elsewhere said, at present it is the valor of the forecaster rather than the value of the forecast which should be commended.

Leaving these infinitely small excursions and the consequences which follow molecular changes, let us consider briefly the movement of air in bulk or the flow commonly called wind. Watching the motes rise and fall in a dusty atmosphere illuminated by a sunbeam, we have all of us tried to puzzle out the causes of the circulation. It seems as if there were neither regularity nor order in the scurrying of the motes, and yet we know that the circulation must depend upon convectional currents and heat difference. Similarly, in plotting the winds of the globe, which at first glance seem to be equally complicated,

PROFESSOR WILLIAM FERREL

one feels that there must be great currents or streams of air due to convection caused by differences in temperature. We do find that there are some great wind systems and the air apparently streams with much steadiness in certain directions. It is not known how early the name Trade was applied to the winds of tropical latitudes. The navigators of the seventeenth century knew of these steady streams and utilized them in exploration and for commerce. The word "trade" had no reference to commerce, but meant persistence. The northeast Trades were the best known. Halley in 1686, Hadley in 1735, Maury in 1855 and Ferrel in 1889 tried to explain the origin of these winds. The early explanation that air moving from north to south (the directions being reversed in the southern hemisphere) passed to regions of constantly increasing rotational velocity and so would lag behind and seem to have an east component, that is, flow toward the west, satisfied the navigators of the seventeenth century, but did not appear valid to Halley, who knew of calm belts near the equator, monsoon winds in the Indian Ocean and southwest winds off the coast of Guinea. He thought that the flow westward might be in some way connected with the apparent diurnal movement of the sun from east to west. Hadley saw that if the march of the sun were a true explanation, then air should flow in from all sides toward the equator, and the flow toward the east be as vigorous as in the opposite direction. He set forth the deflection of north and south winds, not understanding that east and west winds could also be deflected. Maury plotted the winds and in the main followed Hadley. Making free use of a symmetrical or balanced circulation, he indicated the winds and pressure belts of the higher latitudes, misleading Ferrel, who laid stress upon the deflective effect of the earth's rotation and the necessary outflow from belts of high pressure in the latitude of 30° North and South, and also certain polar "lows." All the theories rest upon an assumed heating of equatorial parts and a surface flow of air from the poles toward the equator. In return there must be an upper current from the equator poleward. All these meteorologists fell into the very natural error of taking it for granted that warming the surface air necessarily caused uplift and motion. While there may be change in density, it does not follow that there will be change in pressure unless the volume remains constant. The dynamics of air motion is concerned rather with the gravitational fall of a mass of cold air displacing a mass of warm air at a lower level. To further complicate the problem, recent observations as embodied in the

Réseau Mondial for 1911 show that in certain trade-wind latitudes neither the direction nor velocity accords with the hitherto accepted values for such latitudes.

ABBOTT LAWRENCE ROTCH, 1861–1912
FOUNDER OF BLUE HILL OBSERVATORY

But rather more important than the trades, so far as the commerce of the world is concerned, are the prevailing westerlies, as they are called, meaning the flow of surface air from west to east in temperate latitudes. These winds along the California coast are often erroneously called trade winds. There is no satisfactory explanation of these winds. Taken in connection with commerce, crops and transportation they are easily the most important of the planetary circulations, and there can be no doubt but that a fuller knowledge of their origin and action would be of much value in our national welfare. It is already apparent that air routes for mail and fast passenger service must be determined by the frequency, intensity and duration of these great aerial currents.

We pass now from these major to what may be caller minor circulations, and come first to the seasonal phenomena known in general as monsoons. The word monsoon itself is from the

Arabic and means season. In connection with these seasonal air flows, the Indian Weather Service has done some valuable work bearing on the relation of these winds to the rainfalls, harvests, droughts and famines of that country. There are certain monsoonal effects noticeable in our known distribution of rainfall, and perhaps if more attention were given to the study of these influences, the accuracy of the forecasts would be improved.

The one great advance in recent years in connection with abnormal seasons was made by Tiesserenc deBort, while studying certain cold winters in northwestern Europe. He gave the name "grand centers of action" to certain areas of high and low pressure which appeared to form and dissipate slowly. These are now better known as hyperbars and infrabars. Displacements of these semi-permanent areas appear to coincide with abnormal seasons. On the Atlantic coast it has been shown by Fassig, Humphreys and others that the movements of the north Atlantic infrabar and the Bermuda hyperbar agree with abnormal seasons. On the Pacific coasts McAdie and Okada have successfully used the displacements of the Aleutian infrabar and the continental hyperbars, for forecasting. In a recent study of the flow of the surface air on the north Atlantic seaboard the writer has shown, using the records of the Blue Hill Observatory for a period of 31 years, that in a warm winter month there is an increase in the south and southwest winds and conversely in a cold winter month an increase in duration of north and northwest winds amounting to nearly 10 per cent. of a normal circulation. The temperature appears to be directly determined by the surface wind. Now the conditions favoring a cold winter month seem to be synchronous with a displacement eastward of the ocean infrabar. On the other hand, a strengthening of the Bermuda hyperbar is accompanied by the prevalence of southerly wind and higher temperature. Again, the matter of droughts in the spring is of great importance; and we find that a dry period at this time of the year is unmistakably associated with a marked increase in the duration of west and northwest winds. Evidently the inflow of moisture-laden air from the sea is lessened, and as both vertical and horizontal circulations are less vigorous than usual, there is less condensation, fewer clouds and an absence of both rain and snow. During a wet spring the north Atlantic infrabar is apparently displaced westward and the Bermuda hyperbar intensified. The surface flow from south to north is accelerated, the alternation of cyclone and anti-cyclone becomes more fre-

quent and apparently the dynamic compression of the air is more marked than in dry periods. Here then we begin to lay the foundation for accurate seasonal forecasts, a matter of great importance, in connection with crop yields and national prosperity.

We come next to the individual disturbances known as cyclones and anti-cyclones and the special types of tropical origin called hurricanes, typhoons and baguios. The term cyclone was first used by Piddington, who also proposed the term cyclonology for the new science of storm movement. Typhoon is from the Chinese, meaning violent wind, and baguio is from the Philippine town near Manila. The fact that the air flow in storms is

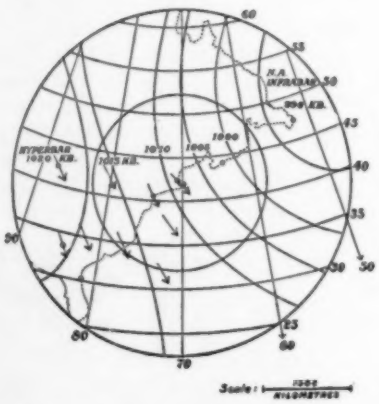


FIG. 1. THE SURFACE AIR FLOW DURING A DRY SPRING. Note: A kilobar (KB) is 1/1000 of a standard atmosphere.

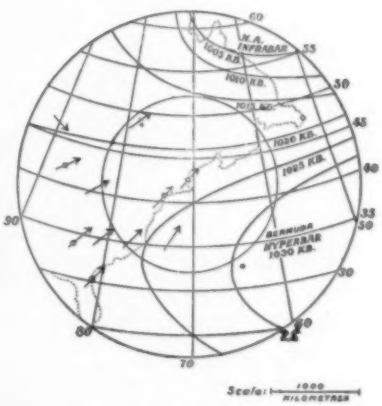


FIG. 2. THE SURFACE AIR FLOW DURING A WET SPRING.

not straight but curved was definitely determined about the middle of the nineteenth century. True there is a paper in the *Philosophical Transactions* for 1698 by Langford describing a West Indian hurricane as a whirlwind and some later references, including one in which Franklin mentions the fact that the air may have traveled many miles in a northeast storm; but it is doubtful if there was any clear concept of the rotational character of a storm at the close of the eighteenth century. Franklin did, however, set forth the fact that storms had a progressive movement, or, in other words, that there was a storm track from Virginia to New England. In a letter to Jared Eliot, July 16, 1747, after describing a wet summer, Franklin says:

We have frequently along this North American Coast storms from

the northeast which flow violently sometimes three or four days. Of these I have had a very singular opinion some years, viz., that though the course of the wind is from the northeast to southwest, yet the course of the storm is from southwest to northeast, that is, the air is in violent commotion in Virginia before it moves in Connecticut and in Connecticut before it moves at Cape Sable, etc.

In another letter to the same correspondent, dated Philadelphia, 13 February, 1750, referring to an eclipse which occurred October 21, 1743, he says:

You desire to know my thoughts about the northwest storms beginning to leeward. Some years since there was an eclipse of the moon at nine o'clock in the evening, which I intended to observe, but before night a storm blew up at northeast and continued violent all night and all next day; the sky thick clouded, dark and rainy so that neither moon nor stars could be seen. The storm did a great deal of damage all along the coast, for we had accounts of it in the newspapers from Boston, Newport, New York, Maryland and Virginia; but what surprised me was to find in the Boston papers an account of an observation of that eclipse made there; for I thought that as the storm was from the northeast it must have begun sooner at Boston that with us, and consequently prevented such observation. I wrote to my brother about it and he informed me that the eclipse was over there an hour before the storm began.

Colonel Capper; Captain Horsburgh; Professor Farrar, of Harvard; W. C. Redfield, a naval architect; Brand, Dove, Reid, Thom, Piddington and Espy established the fact that in the northern hemisphere the motion of rotation was counter clockwise, while in the southern hemisphere it was clockwise. The invention of horn-cards or transparent protractors for anticipating the shift of the wind with the advance of the storm center made it possible for navigators to prepare for the change and take advantage of the shift.

Naturally it was in connection with navigation that this new knowledge found its widest application. Apparently no special use was attempted on land, and as telegraphic communication did not then exist no proposal was made to attempt forecasting. But on the sea it was vital to save ships and many hard and fast rules were laid down for the proper handling of a sailing vessel caught in a rotary storm. As Piddington says:

the navigator was taught first the best chance of avoiding the most violent and dangerous part of a hurricane which is always near the center, next the safest way of managing his vessel, and third the means of profiting by a storm by sailing in a circular course and around, instead of holding to a straight course.

Then came Maury with his "Physical Geography of the Sea." He had the sailor's direct knowledge of the winds.

Graphic indeed are the descriptions of the voyages of the high-masted American clipper ships. The very names tell of the aspiration of their builders. The *Flying Cloud*, the *Archer*, the *Wild Pigeon*, the *Trade Wind*, the *Flying Fish* and the *Glory of the Seas* raced around the world. And our admiration is

DR. JOHN JEFFRIES, OF BOSTON, MASS., FIRST TO TRAVEL BY AIR FROM ONE COUNTRY TO ANOTHER SEPARATED BY THE SEA.

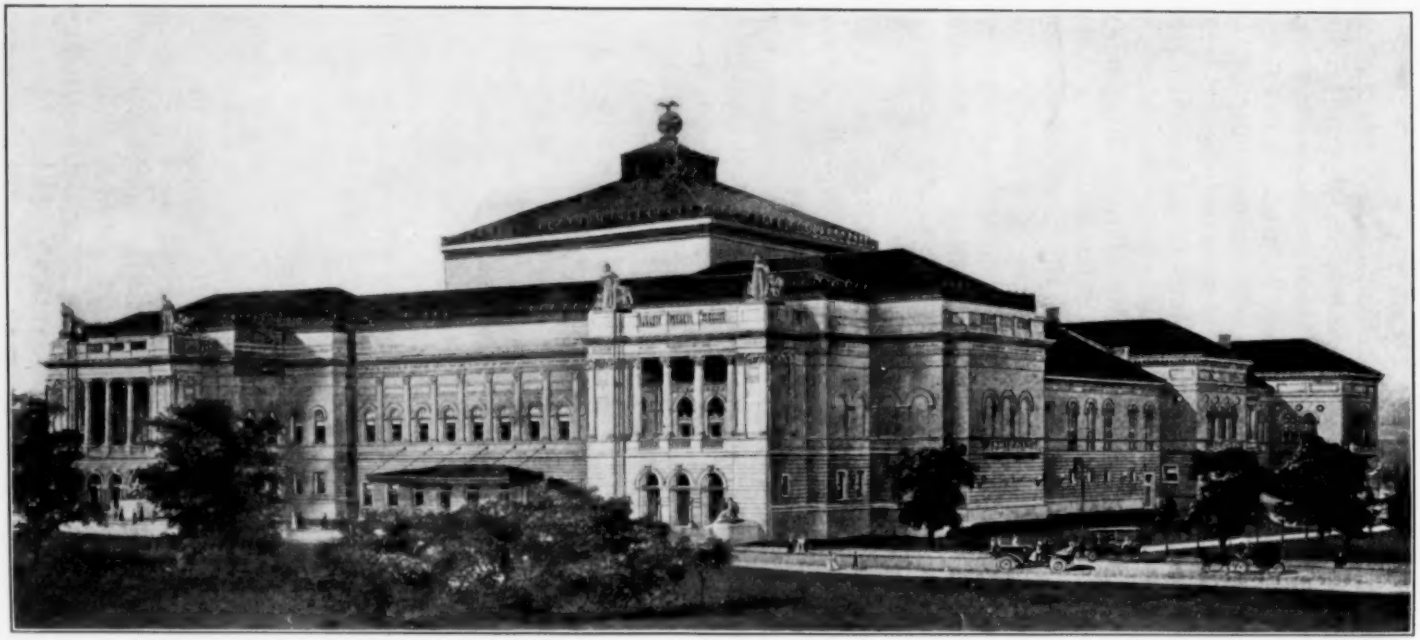
aroused not alone for the clever skippers, but also for the cartographer and investigator whose "Wind and Current Charts" were conned over by these navigators and used to advantage in their struggle for the supremacy of the seas. As illustrating the hydrographer's knowledge of the force, set and direction of the winds and currents of the Atlantic, witness the calculation of the run between New York and the crossing of the equator which vessels of certain rig should make, allowing for adverse winds. The figure given was 4,115 miles. By actual count in two cases the figures came out 4,077 and 4,099. This was the era of our national supremacy on the sea; and Maury's work and wonderful charm of presentation aided in no small degree the attainment of this primacy.

Then came the era of official weather services, inaugurated

in this country by the Signal Corps of the Army. For half a century the work of official weather bureaus has centered in the synoptic map of surface conditions. It is the mainstay of the forecaster and while it has great value, the limit of its possibilities has been reached, for we may say that practically no great improvement has been made in forty years; and the methods of forecasting to-day are essentially the same as when the map was first used. From the very nature of things a map confined to one level can not indicate what is going on in the air at various levels. About fifteen years ago Bigelow attempted the construction of maps at three levels, sea-level, 3,500 feet and 10,000 feet; but the maps as constructed gave rather assumed conditions than the actual state of affairs. It would seem that the closed isobars of the surface open out into loops in the high levels. The temperature distribution, too, is different from that predicated by Ferrel and set forth generally in meteorological text-books. It is far from being a symmetrical distribution. And this in itself upsets the old theory of cyclonic formation and structure. It had indeed been shown from studies of the mean temperatures in anti-cyclones that the old conceptions were faulty. There was need of high-level data and these have been in part supplied by the ascensions of the past ten years, chiefly by kites and sounding balloons and more recently by pilot balloons. A. Lawrence Rotch and Leon Tiesserenc deBort must be regarded as pioneers in the exploration of the upper air. We need not go into detail regarding their work or the more extended efforts of the International Commission for Scientific Aeronautics. The information is given with some detail in an article by Cave in a recent number of the *Quarterly Journal* of the Royal Meteorological Society and also in a book by the writer on Aerography, recently published.

And now we face the era of airplanes through which will come, we hope, the long-desired synchronous survey at various levels. It is evident that what the hydrographer has done for navigation, the aerographer must accomplish for aviation. He takes his place as cartographer and pathfinder of the atmosphere. The logs of the planes will be assembled and the data systematically plotted for the benefit of aerial commerce. And the nation that controls the air, even more than the nation which has supremacy on the sea, will have the command of transportation and communication. It was an American naval officer who brought home to statesmen the influence of sea power upon national destiny. Captain Mahan might modify his views to-day, owing to the advent of aerial fleets, out-speeding, out-

fighting, out-classing the battleships and merchant marine of his time. And our nation has reason to be proud of the important contributions to aerial navigation made by Americans. Maury, Wilkes and Coffin grouped the winds; Rotch issued the first set of charts for aviators and aeronauts, and Dr. John Jeffries was the first to journey by way of the air from one country to another separated by the sea, by a *lighter-than-air* machine, this just one hundred thirty-five years before the era of Zeppelin; and finally Langley, Orville and Wilbur Wright, Maxim, Chanute, Zahn and a host of less well known American engineers, have made flight through the air by *heavier-than-air* machines a matter of daily occurrence. The national air service promises to be the most deadly of the various arms of offense and defense. The air runner is the prospective agency through which all parts of the world shall be made readily accessible. Not only will the now unexplored regions of the earth be mapped, but also the various levels of the atmosphere, particularly in the troposphere, familiarly described as the highways and byways of cloudland. And this new meteorology, airplane meteorology, the science of the structure of the atmosphere, very appropriately carries as its name the significant word, aerography.



THE CARNEGIE INSTITUTE, Headquarters of the American Association for the Advancement of Science.

THE PROGRESS OF SCIENCE

THE PITTSBURGH MEETING OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

THE seventieth meeting of the American Association for the Advancement of Science was held in Pittsburgh, Pa., beginning on December 28, 1917, and continuing until January 3, 1918. At the opening general session on the evening of the first day, held in the lecture hall of the Carnegie Institute, Dr. C. R. Van Hise, retiring president of the association, gave his address, which had for its title "Some Economic Aspects of the World War."

Dr. Van Hise, distinguished equally as a geologist and for his administrative work as president of the University of Wisconsin, has made a special study of the conservation of national resources and related subjects, having prepared recently for the Food Administration an extensive work entitled "Conservation and Regulation in the United States during the World War." His address before the American Association was an authoritative review of the economic situation which should be widely read. He closes with the statement that, while nothing can compensate for the men lost in the war, he believed it probable "that if, following the war, wise governmental regulation is continued for essential commodities as well as the utilities, the savings of the people may be sufficient to meet the money cost of the war."

The addresses of the chairmen of the sections and of the presidents of the special societies, as well as the papers and discussions, in large measure followed President Van Hise in taking up questions concerned with national efficiency and wartime activities. Thus the physicists held a general-interest session on the relationship of physics to the war, and the botanists one on war problems of botany. The zoologists discussed contributions of zoology to human welfare, the entomologists insects and camp sanitation, and how entomologists can assist in increasing food production. Before the Entomological Society, Dr. Vernon F. Kellogg, of Stanford University, made an address on the biological aspects of the war. The botanists chose as the subject for their symposium "phytopathology in relation to war service"; the section of experimental medicine considered the medical problems of the war, which included an address by Lieutenant George Loewy, of the French Army, on the treatment of war wounds by the Carrel method, illustrated by moving pictures. The section of agriculture discussed factors concerned in the increase of agricultural production. Many other addresses and papers might be quoted showing the importance of the meeting in promoting the applications of science to wartime problems.

The total registration at the office of the permanent secretary was 692, distributed as follows: Pennsylvania 194, New York 84, Ohio 59, District of Columbia 44, Illinois 34, Massachusetts 26, West Virginia 21, Indiana 20, Michigan 18, Wisconsin 15, Maryland, Missouri and Canada 14 each, Iowa and Texas 13 each, New Jersey and Virginia 11 each, California 10, North Carolina 8, Connecticut, Tennessee and Kansas 6 each, Minnesota and Arizona 5 each, New Hampshire, Louisiana

THE CARNEGIE INSTITUTE OF TCHNOLOGY, in which many of the meetings of the American Association for the Advancement of Science were held.

and Montana 4 each, Maine, Delaware and Kentucky 3 each, Japan, Nebraska, Utah, Oregon and Colorado 2 each, Rhode Island, Georgia, North Dakota, Arkansas and Wyoming 1 each. The interest of the meeting was enhanced by the presence of the following foreigners, who were made honorary associates for the meeting: Lieutenant Georgia Abbetti, of the Italian Military Commission; Lieutenant G. P. Thompson, of the Royal Flying Corps of Great Britain; Captain DeGuiche, of the French Military Commission, and Dr. Shigetaro Kawasaki, chief geologist of Korea.

It was decided to hold the next meeting of the association in Boston, Massachusetts, the meeting to begin on Friday, December 27, 1918. This decision was adopted with the amendment that the committee on policy be given the power to cancel the meeting, or to change the place should this seem to be desirable. It was recommended that St. Louis be chosen for the place of meeting following Boston.

The following officers were elected:

President, John M. Coulter, the University of Chicago;

Vice-presidents as follows:

Section A, Mathematics and Astronomy, George D. Birkhoff, Harvard University;

Section B, Physics, Gordon T. Hull, Dartmouth College;

Section C, Chemistry, Alexander Smith, Columbia University;

Section D, Mechanical Science and Engineering, Ira N. Hollis, Worcester Polytechnic Institute;

Section E, Geology and Geography, David White, U. S. Geological Survey, Washington, D. C.;

Section F, Zoology, Wm. Patten, Dartmouth College;

Section G, Botany, A. F. Blakeslee, Cold Spring Harbor;

Section H, Anthropology and Psychology (no election);

Section I, Social and Economic Science, John Barrett, Washington;

Section K, Physiology and Experimental Medicine, Frederic S. Lee, Columbia University;

Section L, Education, S. A. Courtis, Detroit, Mich.;

Section M, Agriculture, H. P. Armsby, Pennsylvania State College.

WAR-TIME ACTIVITIES OF THE GEOLOGICAL SURVEY

THE activities of the Geological Survey, Department of the Interior, during the fiscal year 1916–17 have been concentrated on investigations connected with military and industrial preparedness, as shown by the Annual Report of the director of the survey. These activities have included the preparation of special reports for the War and Navy Departments and the Council of National Defense, the making of military surveys, the printing of military maps and hydrographic charts, and the contribution of engineer officers to the Reserve Corps.

The survey's investigations of minerals that have assumed special interest because of the war have been both expanded and made more intensive. Special reports giving results already at hand, the product of years of field and office investigation, have been published for the information of the general public or prepared for the immediate use of some official commission, committee or bureau. Geologic field work has been concentrated on deposits of minerals that are essential to the successful prosecution of the war, especially those of which the domestic supply falls short of present demands. Every available oil geologist is at work in petroleum regions where geologic exploration may lead to increased production. Other geologists are engaged in a search for commercial deposits of the "war minerals"—manganese, pyrite, plati-

num, chromite, tungsten, antimony, potash and nitrate.

The war not only diverted practically all the activities of the topographic branch of the survey to work designed to meet the urgent needs of the war department for military surveys, but led to the commissioning of the majority of the topographers as reserve officers in the Corps of Engineers, United States Army.

A large contribution to the military service is made by the map-printing establishment of the survey. This plant has been available for both confidential and urgent work, and during the year has printed 96 editions of maps for the war department and 906 editions of charts for the navy department. Other lithographic work, some of it very complicated, was in progress at the end of the year.

WORK OF THE NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS

THE annual report of the executive committee of the National Advisory Committee for Aeronautics states that previous to the entrance of the United States into the war the committee had undertaken a census of the production facilities of manufacturers of aircraft and aeronautic engines, which information was made available for use of the Aircraft Production Board at the beginning of its work in April.

In October, 1916, the committee took under consideration the question of the selection of a suitable site for the committee's proposed experimental laboratory. At the suggestion of the War Department this committee inspected several proposed sites and made recommendation to the War Department for the purchase of one of them, which recommendation was accepted by the War Department and the site was purchased. On this field the War Department has allotted to the committee a space suited to the erection of the committee's proposed research laboratories. The committee has designed the first building of the group contemplated and it is now in the course of construction.

SCIENTIFIC ITEMS

WE record with regret the death of Theodore Caldwell Janeway, professor of medicine at the Johns Hopkins University; of Albert Homer Purdue, state geologist of Tennessee; of Joseph Price Remington, dean of the Philadelphia College of Pharmacy; of Hugo Schweitzer, the industrial chemist; of Louis Pope Gratacap, curator of mineralogy in the American Museum of Natural History; of A. M. W. Downing, formerly superintendent of the British *Nautical Almanac*, and of Fritz Daniel Frech, professor of geology and paleontology in the University of Breslau.

M. PAINLEVÉ has been elected president of the Paris Academy of Sciences, succeeding M. d'Arsonval.

—In recognition of his contributions to science, Colonel Theodore Roosevelt has been appointed honorary fellow of the American Museum of Natural History, of which his father, Theodore Roosevelt, Sr., was one of the founders and most energetic supporters.

The committee has made progress during the year in the study and investigation of the following problems: Stability as determined by mathematical investigation, air-speed meters, wing sections, aeronautical engine design, radiator design, air-propeller design and efficiency, forms of airplane, radio telegraphy, noncorrosive materials, flat and cambered surfaces, terminal connections, characteristics of constructive materials, and standardization of specifications for materials.